

CANADA – BRITISH COLUMBIA

WATER QUALITY MONITORING AGREEMENT

WATER QUALITY ASSESSMENT OF Pend d'Oreille River AT WANETA (1980 – 2006)



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Prepared for:
Ministry of Environment
and
Environment Canada

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Environment Environnement
Canada Canada



Ministry of
Environment

EXECUTIVE SUMMARY

The Pend d'Oreille River accounts for 43% of the drainage area of the Columbia River as it enters the USA downstream from Waneta. It drains 65,300 km² in the USA before entering B.C., where it drains an additional 1600 km² before joining the Columbia River at Waneta about 22 km downstream.

The Pend d'Oreille River in B.C. is dominated by hydroelectric facilities, with the Boundary Dam at the Canada-US border, the Waneta Dam just upstream from the Columbia River, and the Seven Mile Dam midway between the two. The three dams are barriers to migration to all fish. The river provides habitat for a wide variety of fish species, including sports fish such as bull trout, rainbow trout, brook trout, mountain whitefish, and Westslope (Yellowstone) cutthroat trout. Minor quantities of water are licensed for irrigation and domestic use. Other potential influences on water quality are mines (both active and closed), forestry, and agriculture.

Some metals concentrations exceed guidelines on occasion during high flow/high turbidity periods (spring runoff/snowmelt). Elevated turbidity levels are likely natural, although they may be increased by past and present upstream activities. It is unlikely that aquatic life would be impacted by these short-term turbidity-driven metal exceedances.

CONCLUSIONS

- Turbidity levels and specific conductivity fluctuate throughout the year in response to flow conditions. Turbidity increases during freshet periods when runoff carries solids from the land surface. Specific conductivity is generally at its highest when flows are low and the influence of ground waters that are harder than the surface water has most influence on water quality.
- Water temperatures (and likely dissolved oxygen concentrations but these have not been measured) fluctuate throughout the year, with highest water temperatures occurring during the warmer summer months as would be expected. This is a

period when we would expect the lowest dissolved oxygen concentrations because warmer water has a lesser capability to hold dissolved oxygen than colder water.

- The data indicate that several metals that occasionally have values that exceed guidelines to protect aquatic life are associated with high concentrations of particulate matter. This means that the metals are likely in particulate form and are not biologically available and would be removed with treatment of this source water when used for drinking.
- Fecal coliforms were considerably less than the guideline for source waters used for drinking that are not treated other than by disinfection.
- One true colour value was associated with a high turbidity level, and this would be removed by treatment used to remove solids when the water is used as a source for drinking. Colour is an aesthetic concern and not a health issue per se.
- Water temperature frequently exceeded the guideline to protect aquatic life during summer periods, but the margin above the guideline was small.
- Analytical detection limits used for many metals has improved considerably in the period from 2003-2006. This has resulted in fewer values exceeding guidelines during that period. This relates to the fact that many of the former high values may have been “false positives” which is common when values are close to the detection limit. The new lower detection limits help to avoid such problems and allow us to present a more accurate picture of water quality.
- There did appear to some long-term trends of increasing values through the period of record at this station for the following variables although none were environmentally significant: boron, chloride, and magnesium. Each of these needs to be verified by a statistical analysis.
- There did appear to some long-term trends of decreasing values through the period of record at this station for the following variables although none were environmentally significant: antimony, lithium, rubidium, silicon, sulphate, specific conductivity, thallium, and uranium. Each of these needs to be verified by a statistical analysis.

RECOMMENDATIONS

We recommend monitoring be continued for the Pend d'Oreille River at Waneta since it serves as an upstream station for the lower Columbia River site.

Water quality indicators that are important for future monitoring are:

- flow, water temperature, specific conductivity, pH, turbidity, nutrients, and dissolved oxygen,
- appropriate forms of metals for comparison to their respective guidelines, and
- other variables related to drinking water such as colour.

ACKNOWLEDGEMENTS

The photos on the cover are reproduced courtesy of Carrie Morita of the Ministry of Environment in Nelson. The graphs in this report were prepared by Sacha Wassick of Environment Canada. The draft report was reviewed by Jolene Raggett of Ministry of Environment and Andrea Ryan of Environment Canada. We thank these individuals for their contributions to improving this document. Any errors or omissions are the responsibility of the author.

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INTRODUCTION

Since 1985, Ministry of Environment and Environment Canada have been cooperatively measuring water quality at a number of locations in British Columbia. The express purposes of this joint monitoring program have been to define the quality of the water and to determine whether there are any trends in water quality.

The Pend d'Oreille River drains 65,300 km² in the USA before entering B.C., where it drains an additional 1600 km² before joining the Columbia River at Waneta about 22 km downstream. Thus, 98% of the Pend d'Oreille drainage area lies in the USA, with only 2% in Canada. The Pend d'Oreille River accounts for 43% of the drainage area of the Columbia River as it enters the USA downstream from Waneta.

The Pend d'Oreille River in B.C. is dominated by hydroelectric facilities, with the Boundary Dam at the Canada-US border, the Waneta Dam (1954) just upstream from the Columbia River, and the Seven Mile Dam (1979) midway between the two. There are six water licences on the Pend d'Oreille River, four for power generation and one each for irrigation and domestic use. The river provides habitat for a wide variety of fish species, including sports fish such as bull trout, rainbow trout, brook trout, mountain whitefish, and Westslope (Yellowstone) cutthroat trout. The three dams are barriers to migration to all fish.

Potential influences on water quality in the US portion of the watershed include dams, forestry, agriculture and mining, as well as a lead-zinc concentrator at Metaline Falls (about 10 km upstream from the Canada-U.S. border) that may discharge tailings pond supernatant in Washington State.

There are three closed mines in the B.C. portion of the watershed:

1. A lead-zinc mine at Remac on the north bank of the Pend d'Oreille River that operated during 1948-75, with tailings and mine water discharged to the river until 1974.

2. A lead-zinc mine on Sheep Creek operated from 1955- 78. Tailings were deposited in a 20-hectare tailings pond adjacent to the Salmo River south from Sheep Creek. Decant from the tailings pond discharged to the Salmo River, and in March 1975 an ice jam in the tailings pond caused tailings to enter the river. The tailings flume along Sheep Creek was in poor condition and there were numerous spills to the creek.
3. A tungsten-lead-zinc mine on Lime Creek operated from 1953-73. Tailings and other mill effluents were discharged to a tailings pond that decanted to Lime Creek along with mine water. Lime Creek flows into Lost Creek, which flows into the South Salmo River (Ministry of Environment 1977 & 1979).

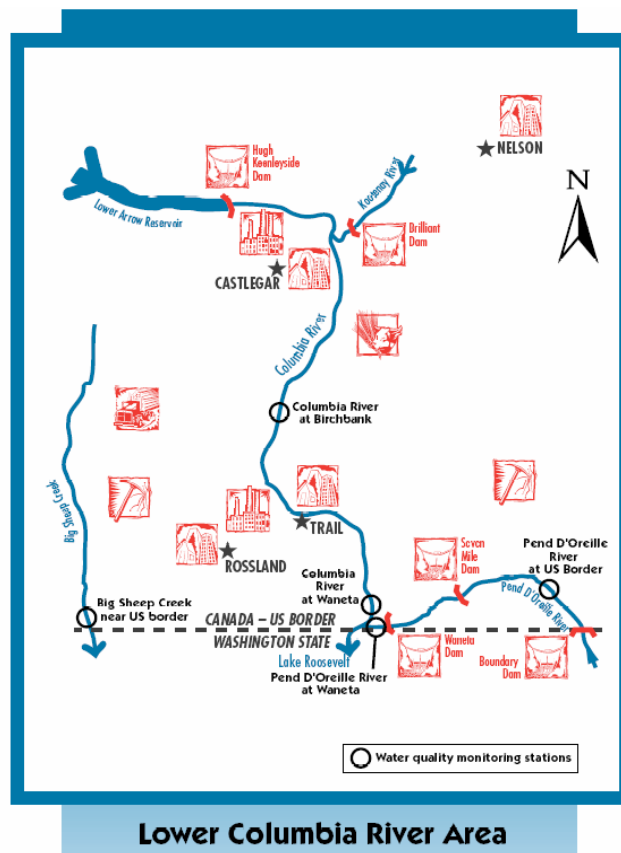


FIGURE 1: PEND D'OREILLE RIVER AT WANETA

WATER QUALITY ASSESSMENT

Data for the Pend d'Oreille River at Waneta have been collected on a frequency of about once every two weeks. As well, twice per year, two additional samples are collected in order to ensure that there are two periods when weekly samples are collected during five consecutive weeks. In addition, quality assurance samples (blanks and replicates) are collected six times per year. These results for each variable were used in this assessment to identify potential outliers that should be removed from consideration of trends, and to “flag” questionable data in the database (www.waterquality.ec.gc.ca) as to possible or likely errors.

This assessment is based on water quality data collected during 1980-2006. The Pend d'Oreille River at Waneta station was moved from the north bank of the river downstream from Waneta Dam to the face of the dam in the tailrace on 15-Jan-98 because of concerns that the samples contained Columbia River water at times of high flow in the Columbia and low flow in the Pend d'Oreille. The state of the water quality was assessed by comparing the values to the B.C.'s approved and working guidelines (if guidelines exist for the variable) for water quality (Ministry of Environment, 2006a and b), and by looking for any obvious trends in the data. Any levels or apparent trends that were found to be deleterious or potentially deleterious to sensitive water uses, including drinking water, aquatic life, wildlife, recreation, irrigation, and livestock watering were noted in the following variable-by-variable discussion described below in alphabetical order. These trends are further evaluated to ensure that they were not caused by measurement errors, to identify their causes, and to determine whether they are statistically significant. A confidence level of 95% or better is used to define statistical significance, unless noted otherwise.

When concentrations of a substance cannot be detected, we have plotted the concentration at the level of detection. We believe this to be a conservative approach to assessing possible trends. We have normally plotted each variable against either turbidity

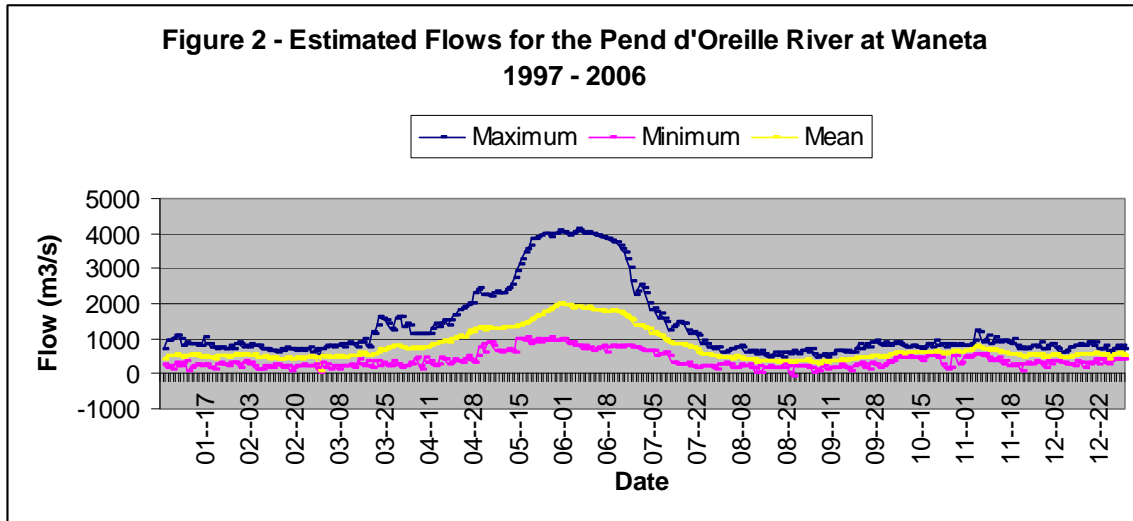
levels or specific conductivity, whichever we believe from experience may be correlated with the particular variable. Sometimes, we have plotted the same variable for two or three different periods of time, usually to highlight periods of time when analytical detection limits may have improved. In such cases, one plot will include the entire period of record for the variable. As well, there are times when measurements were not taken for some reason. In these cases, straight lines will join the two consecutive points and may give the illusion on the graph of a trend that does not exist.

In some cases, testing for the presence of a variable has been terminated after a certain period. In general, this has been because a previous data assessment and review has indicated that collections of these data are not warranted for this station. For other variables, concerns about concentrations may have only arisen in recent years.

The following water quality indicators were not discussed as they met all water quality guidelines (if guidelines exist) and showed no clearly visible trends: bromide, fecal coliforms, nitrite, and tin.

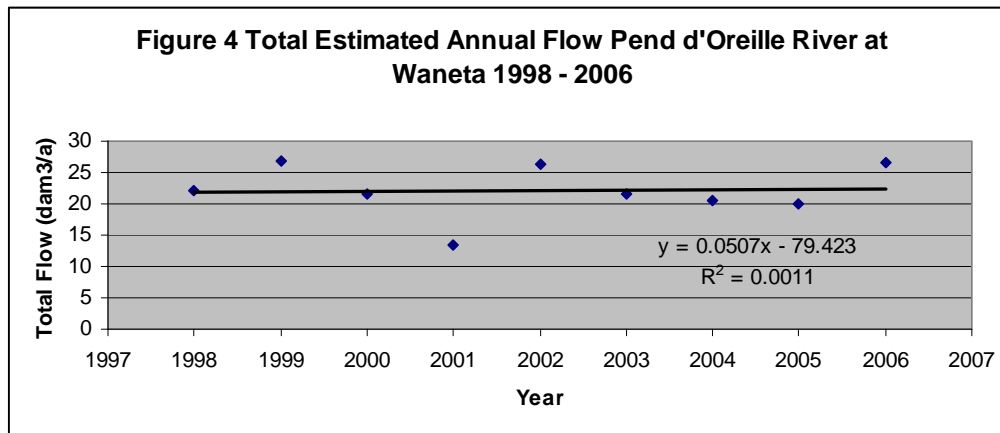
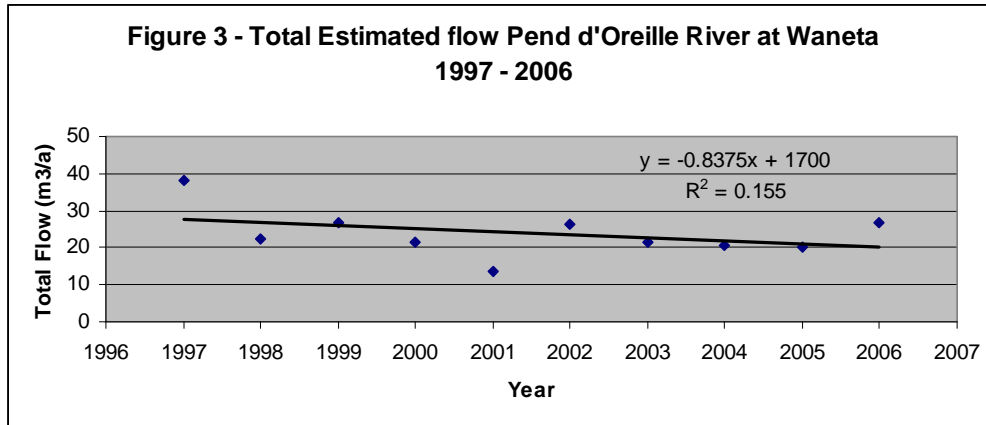
The following water quality indicators seemed to fluctuate through the year according to turbidity concentrations, but were below guideline values (if guidelines exist) and had no other trends: arsenic, beryllium, bismuth, dissolved organic carbon, cobalt, gallium, lanthanum, manganese, molybdenum, niobium, nickel, non-filterable and fixed non-filterable residue, selenium, and vanadium.

Other water quality indicators seemed to fluctuate through the year according to the specific conductivity of the water. For dissolved forms of many of these indicators, they would be a part of the measured conductivity, and this is to be expected. These types of indicators that were not measured above guideline values (if guidelines exist) included: barium, dissolved inorganic carbon, calcium, potassium, dissolved nitrate, total dissolved nitrogen, sodium, pH, filterable and fixed-filterable residue, and strontium.



Flow (Figure 2): There is no flow station on the Pend d'Oreille River at Waneta and this can only be estimated by subtracting flows for two Columbia river sites at the border and at Birchbank. This is what we have done to generate Figure 2. As can be seen, peak flows occur from mid-April through mid-July, with low flows that are generally less than 1000 m³/s the remainder of the year. Peak flows are generally about 2000 m³/s although they were double this in 1997.

Pommen Water Quality Consulting (2003) indicated that there was a declining trend in flows during 1997-2001. When we examined the flows between 1997 and 2006, a declining trend also was apparent (Figure 3); however, this related to the extremely high flows in 1997. When this year was removed from the data set (Figure 4), flows were generally similar from 1998 – 2006. Thus we believe that the noted declining trend was simply an aberration.



Aluminum (Figure 5) concentrations frequently exceeded guidelines for the protection of aquatic life; however, the measurements were as total or more frequently, also as extractable while the guideline is as a dissolved fraction. High aluminum concentrations were correlated with high turbidity levels, meaning that the aluminum would be in particulate form and not likely biologically available.

Alkalinity (Figure 6) fluctuated throughout the year, with the highest values corresponding to high conductivity at low flow. It is expected that the influence of ground water on base flows and hence water quality would be greatest during these periods.

Antimony (Figure 7) has only been measured between 2003 and 2006; however, there appears to have been a declining trend in values during that period ($R^2 = 0.14$ for total

and 0.10 for extractable for linear regression). It is not known whether this apparent trend is a result of the short length of time of the database or is in fact a real trend. However, values are not environmentally significant and may be correlated with conductivity levels.

Boron (Figure 9) values are well below all guidelines; however, there appears to be a trend of increasing concentrations since 1997 period ($R^2 = 0.12$ for total and 0.11 for extractable for linear regression). However, if the data for extractable boron for 1997 (high flow year) are eliminated from the data set, the R^2 value declines to 0.07 from 0.11. Boron concentrations appear to be correlated with conductivity.

Cadmium (Figures 18 and 19) values occasionally exceeded the guideline for the protection of aquatic life that varies with water hardness. These higher values were correlated with turbidity levels which mean that they were likely in particulate form and not biologically available.

Chloride (Figure 20) values appear to possibly be increasing through time, with a R^2 of 0.08 for a linear regression. Chloride concentrations are correlated to specific conductivity.

Colour (Figure 22) when measured as true colour exceeded the guideline for source waters used for drinking on one occasion. Colour definitely appears to be correlated to turbidity, meaning that if turbidity removal is employed to treat the source water, that the colour will be reduced as well. Colour is an aesthetic guideline and not a health issue per se.

Chromium (Figures 23 and 24) when measured as total chromium occasionally exceeded the hexavalent chromium guideline to protect aquatic life prior to 1997. After that time, all values when measured as total chromium have been below the guideline for hexavalent chromium. This has been even more pronounced with lower detection limits (and the elimination of more false positives) in 2001 and 2003 for extractable and total

forms, respectively. Chromium concentrations appear to be correlated to turbidity, meaning that when the higher chromium values were measured, that the chromium was likely in particulate form and not biologically available.

Copper (Figure 25) infrequently has exceeded the guideline for the protection of aquatic life that is hardness-dependent. Copper seems to be correlated to turbidity which means that the copper is likely in particulate form and not biologically available.

Fluoride (Figure 26) values were generally less than the guideline to protect aquatic life, although one high value in the early 1980's exceeded the guideline. All other values since that time have been well below the guideline, and so we consider this value as an outlier. Fluoride values are correlated with specific conductivity.

Iron (Figure 27) values frequently exceeded guidelines; however, all but one of these high values was before 1998. Iron concentrations seem to be correlated with turbidity, meaning that the iron is in particulate form. This means that for aquatic life, that the iron would not be biologically available while for source waters used for drinking, that it would be removed with turbidity removal.

Hardness (Figure 30) concentrations sometimes were in the range from 80 to 100 mg/L, indicating a moderate hardness for source waters used for drinking. These higher values were correlated to higher specific conductivity, meaning that the values likely reflected a larger influence from ground water which would be harder than surface waters.

Lead (Figure 33) values occasionally exceeded the guidelines to protect aquatic life. Lead concentrations were correlated with turbidity levels, meaning that the lead was likely in particulate form and not biologically available.

Lithium (Figures 34 and 35) values have been measured since 1990 as total concentrations, and since that time have shown a reduction based on a linear regression

($R^2 = 0.24$). Extractable concentrations have been measured since some time in 1997; however, no such reduction has taken place. It is not known whether this apparent reduction relates to some management action in the watershed, or whether it is in fact a true downward decline. Values recorded since 1997 have shown no decline in concentration. Lithium values seem to be correlated with specific conductivity.

Magnesium (Figure 36) values in the period from 1990 to 2003 appear to be increasing through time, with a R^2 value of 0.07 for extractable magnesium. No such trend was observed for dissolved magnesium concentrations in the periods before and after this, so we suspect there really has been no change.

Phosphorus (Figure 46) concentrations have shown a small decline based on a linear regression ($R^2 = 0.035$); however, this decline is likely simply related to decreased detection limits in recent years and the associated precision and accuracy associated with this.

Rubidium (Figures 48 and 49) values seem to be correlated with turbidity. Concentrations also appear to be decreasing, with extractable values declining with a R^2 value of 0.191 when using a linear regression analysis.

Silicon (Figure 55) and **Silica** (Figure 56) values appear to be correlated with specific conductivity and to be decreasing through time. Silicon was only measured between January 2000 and April 2002 and showed a considerable decrease in that period ($R^2 = 0.13$ using a linear regression) while dissolved silica from 1990 until 2000 showed an upward increase ($R^2 = 0.097$).

Silver (Figures 57 and 58) prior to 2003 rarely exceeded the guideline for aquatic life of $0.1 \mu\text{g/L}$; however, the analytical detection limit was at the $0.1 \mu\text{g/L}$ level and the rare high values were considered to be likely noise associated with the measurement. Since 2003, when analytical detection limits were ten times lower, all values have been well

below the guideline and in fact, all were well below the lower guideline of 0.05 µg/L as a 30-day mean concentration. Thus we believe that there is no concern related to silver in the river. Silver concentrations appear to be correlated with turbidity.

Specific Conductivity (Figure 59) values fluctuated throughout the years, with highest values coinciding with low flow periods. The higher conductivity values likely reflect the increased influence of harder ground water. Specific conductivity values may be decreasing through time ($R^2 = 0.05$).

Sulphate (Figure 61) values show the same downward trend in concentration that specific conductivity did, with a R^2 value of 0.23 based on a linear regression. Sulphate concentrations are well correlated with specific conductivity.

Temperature (Water - Figure 62) values fluctuate throughout the year, with highest values being during the hot summer months. At those times, values can exceed the guideline for streams with unknown fisheries distribution.

Thallium (Figures 64 and 65) values are correlated with turbidity and have declined since about 1997, based on a linear regression ($R^2 = 0.30$).

Turbidity (Figure 66) fluctuates throughout the year, with highest values during freshet. During those periods, the guideline for source waters used for drinking water supplies can be exceeded and turbidity removal would be required to ensure efficient disinfection.

Uranium (Figure 67) values are correlated with specific conductivity. Values seem to have declined through time using a linear regression ($R^2 = 0.09$).

Zinc (Figure 69) values (individual) have occasionally exceeded the 30-day mean guideline to protect aquatic life. No individual values since the late 1990's have exceeded

the guideline. Zinc concentrations appear to be correlated with turbidity, which means that any high zinc was likely in particulate form and not biologically available.

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- Ministry of Environment. 2006a. British Columbia. A Compendium of Working Water Quality Guidelines for British Columbia. Environmental Protection Division, Ministry of Environment. Victoria, B.C.
- Pommen Water Quality Consulting. Water Quality Assessment of the Pend d'Oreille River at the U.S. Border (1997 – 2003). November 2003.

Figure 5
Pend D'Oreille River at Waneta
 Aluminum Total and Extractable

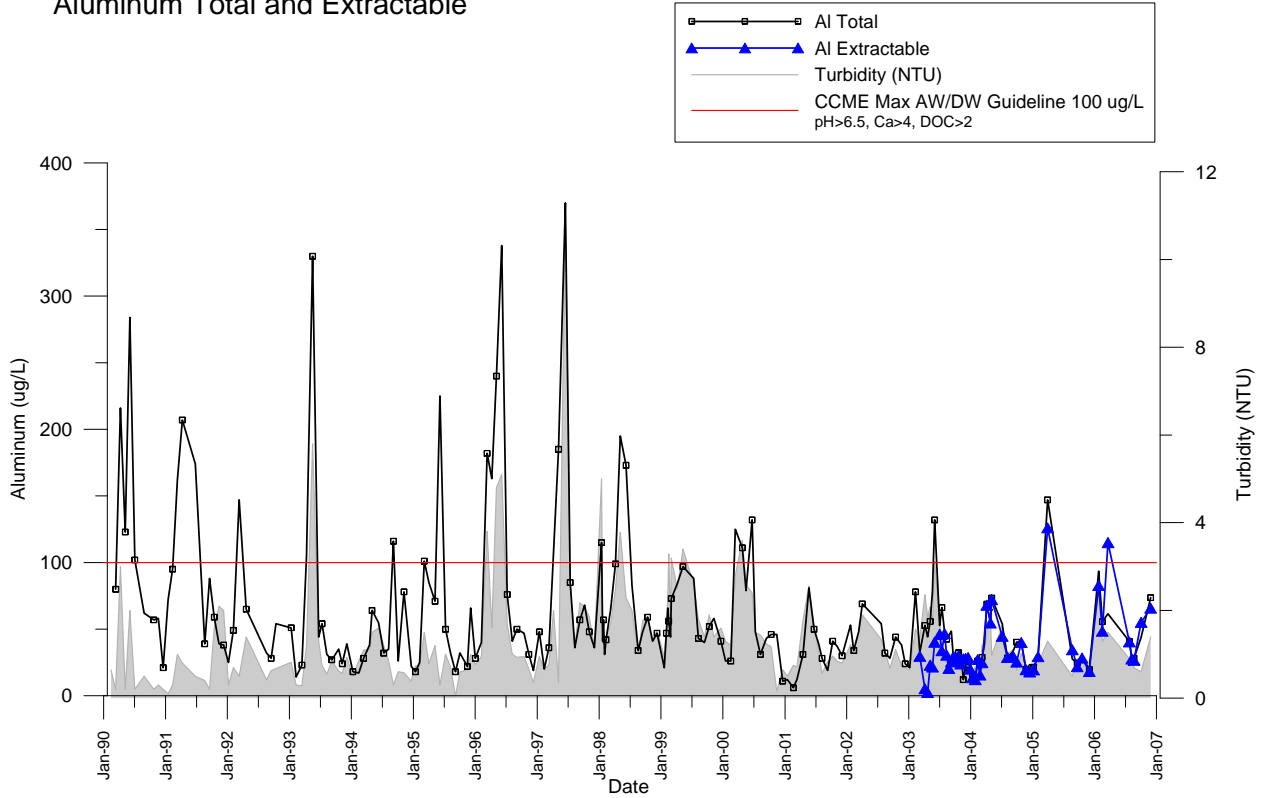


Figure 6
Pend D'Oreille River at Waneta
Alkalinity Total

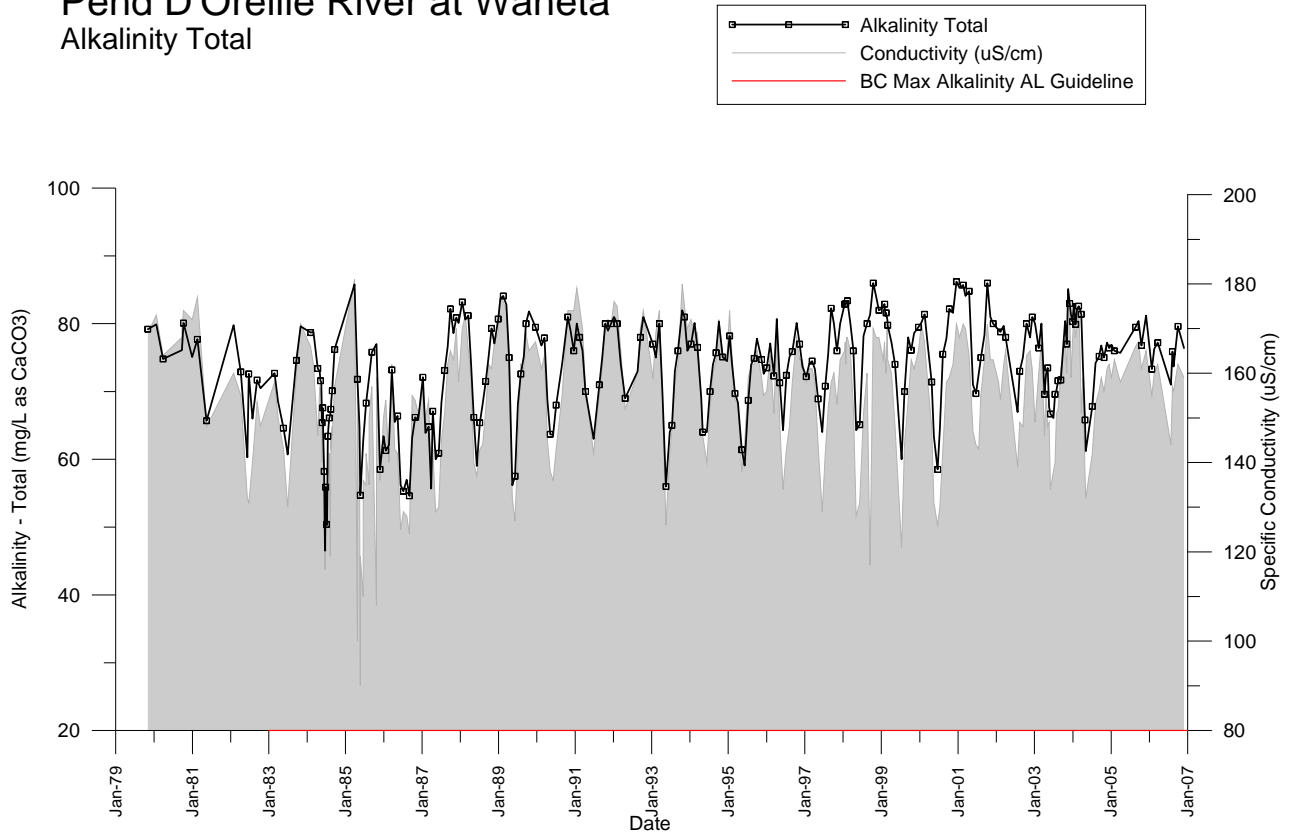


Figure 7
Pend D'Oreille River at Waneta
Antimony Total and Extractable

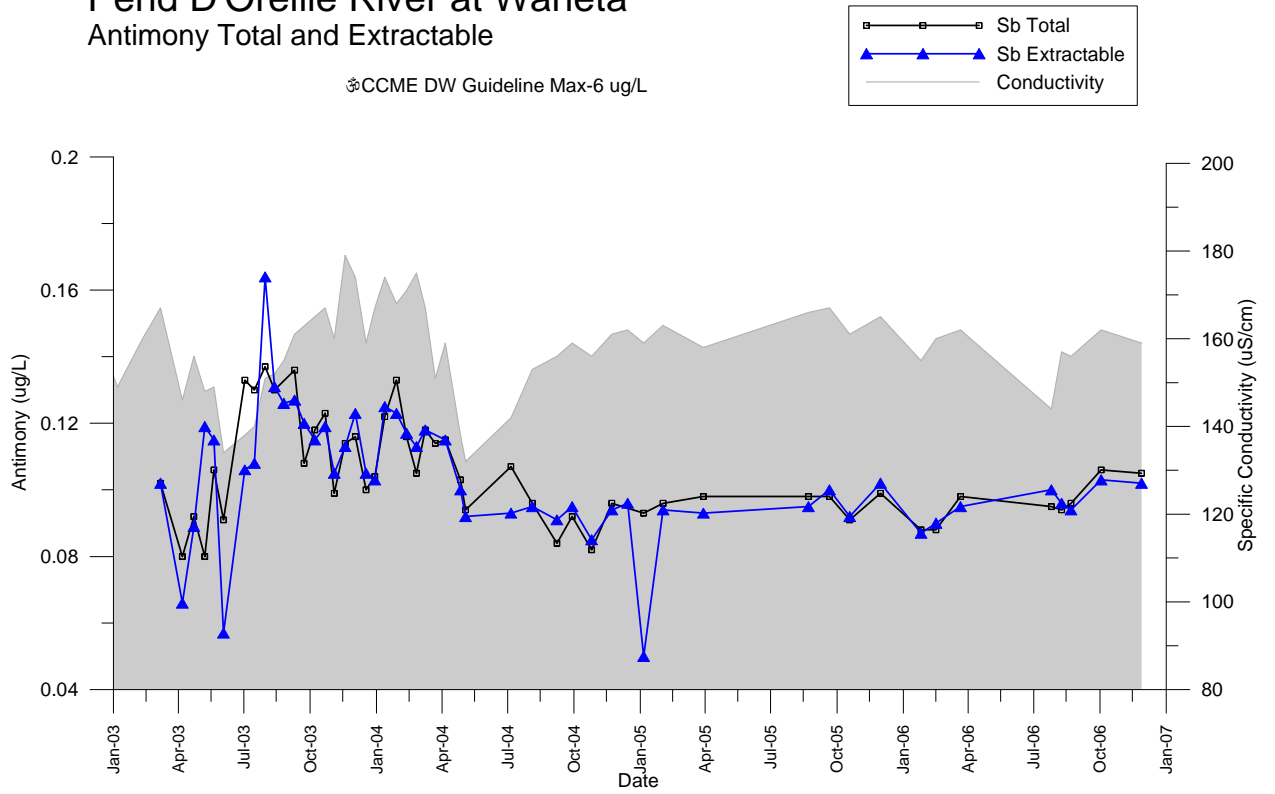


Figure 8
Pend D'Oreille River at Waneta
Arsenic Total and Extractable

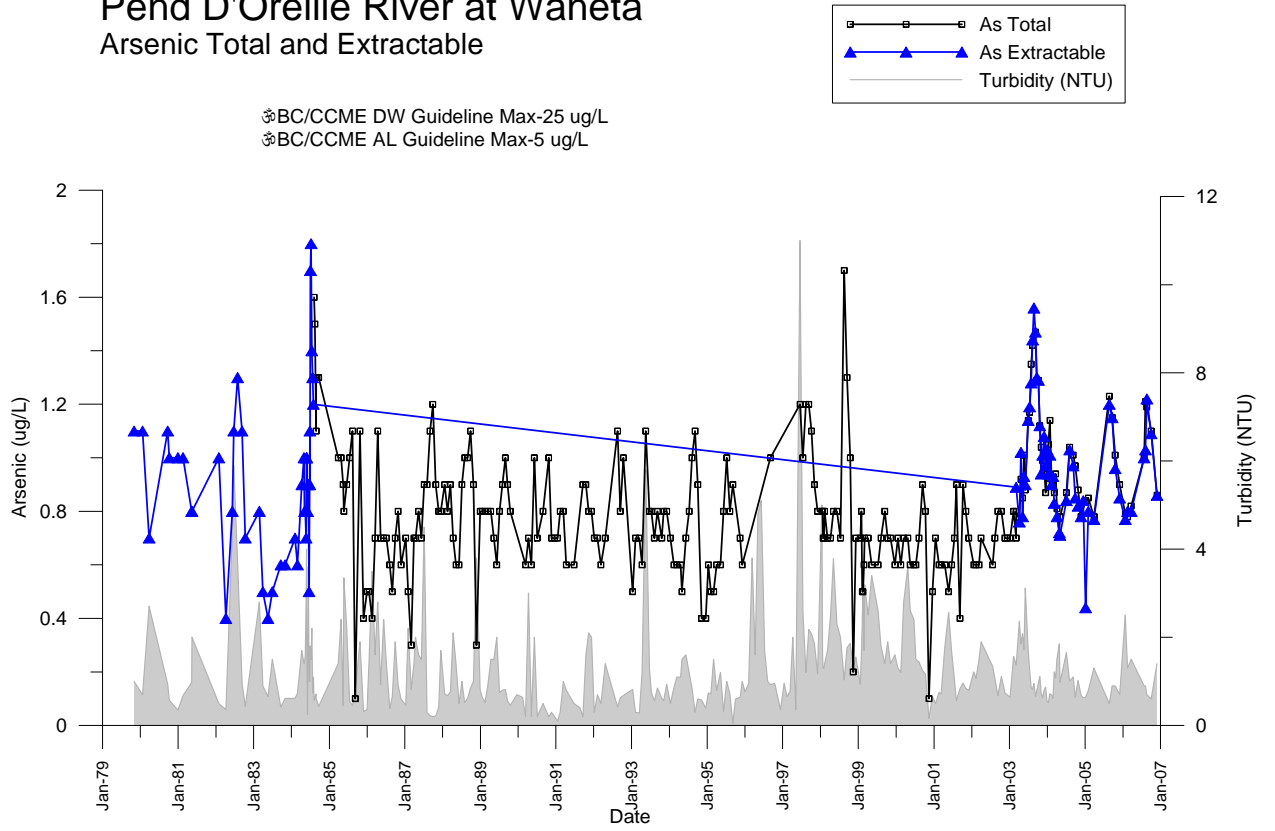


Figure 9
Pend D'Oreille River at Waneta
Boron Total and Extractable

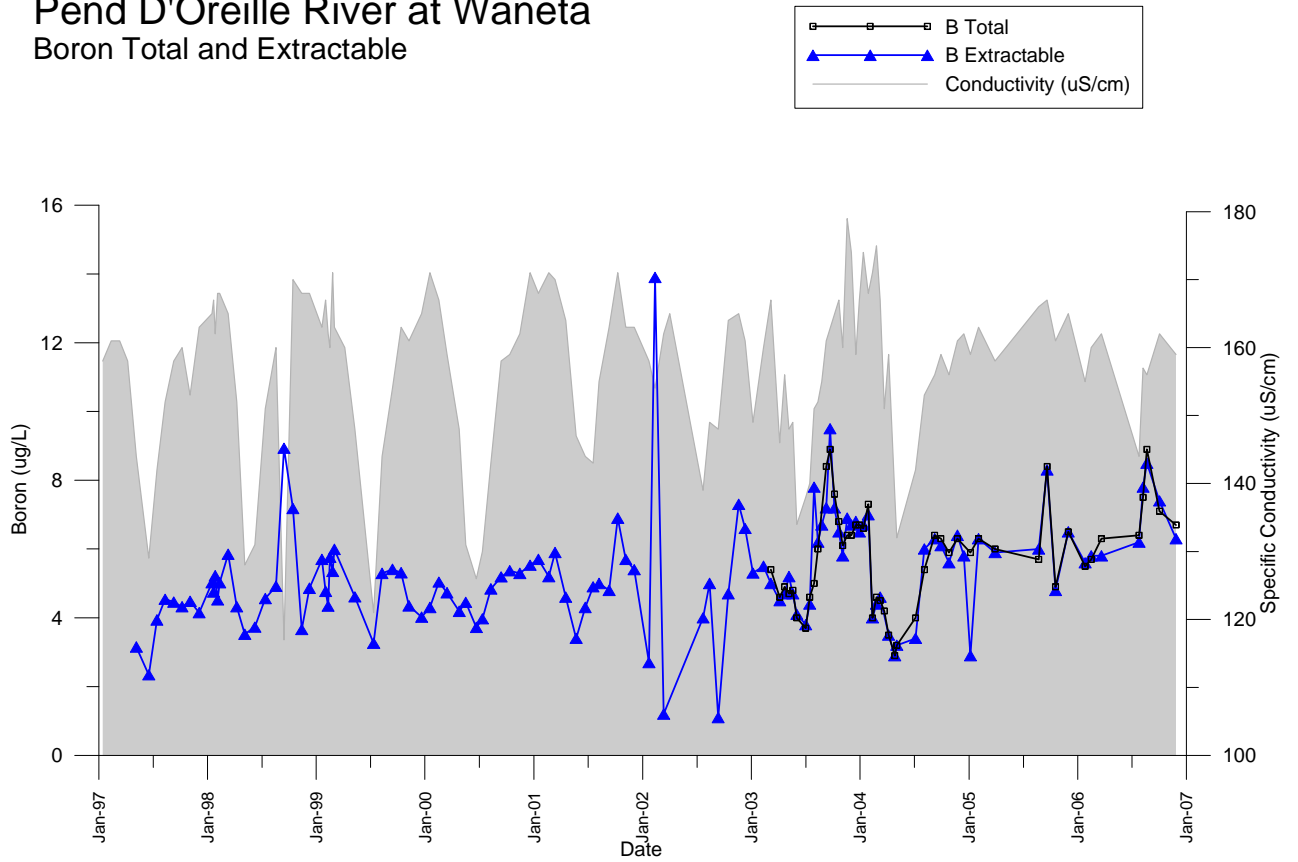


Figure 10
Pend D'Oreille River at Waneta
Barium versus Turbidity

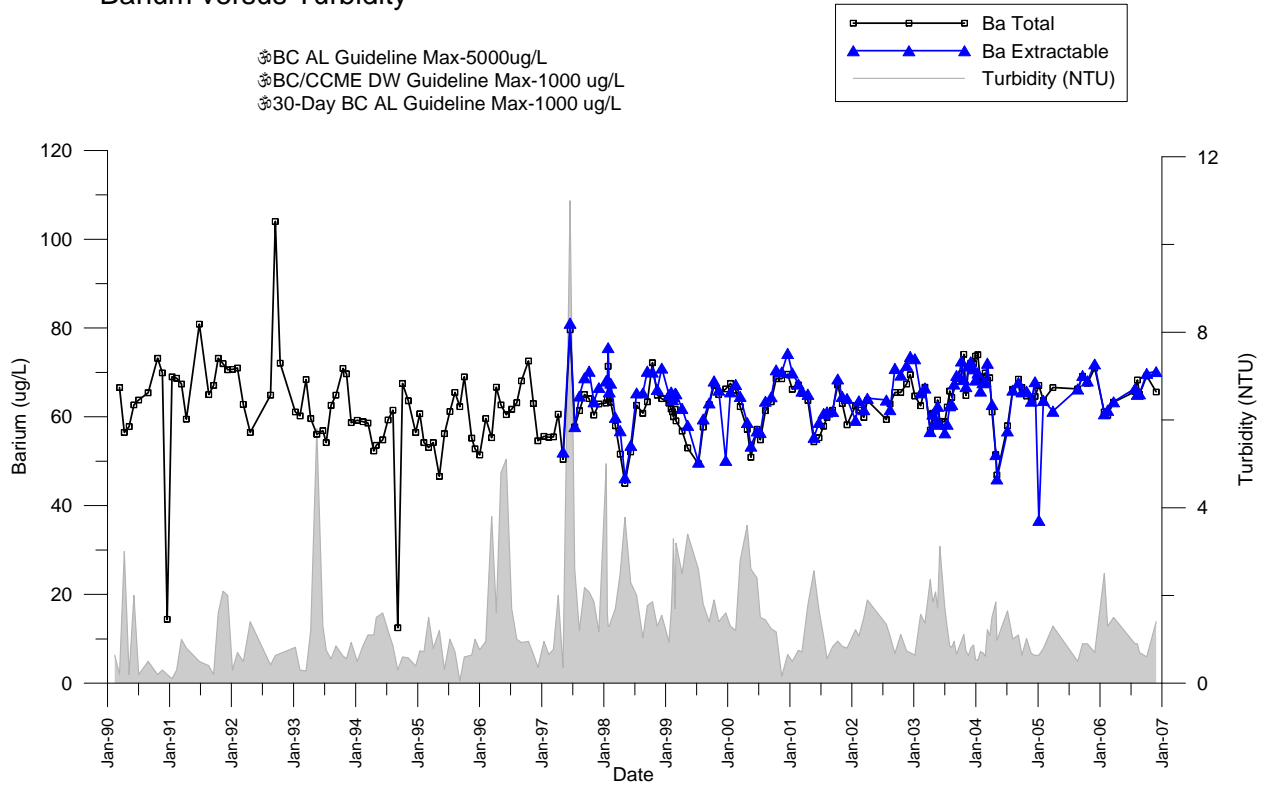


Figure 11
Pend D'Oreille River at Waneta
Barium versus Specific Conductivity

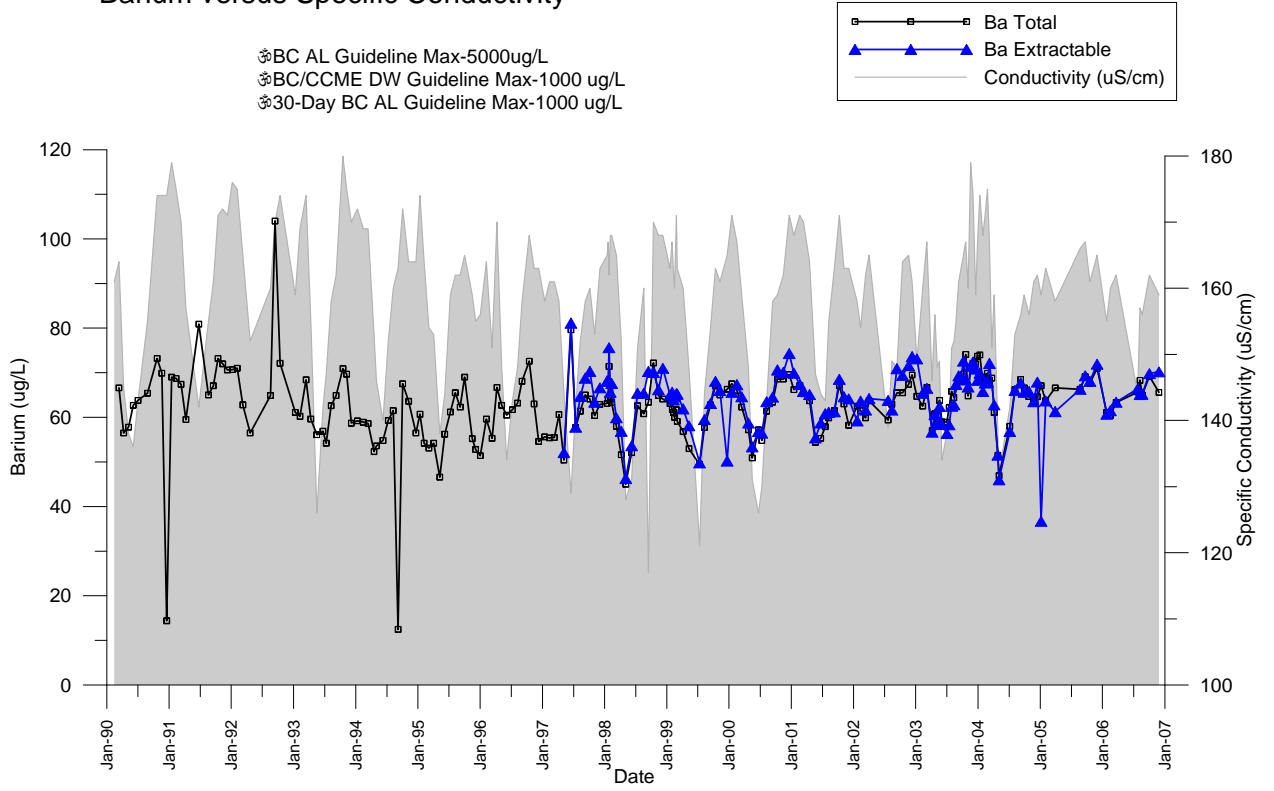


Figure 12
Pend D'Oreille River at Waneta
Beryllium Total and Extractable

⊗ BC AL Guideline Max-5.3 ug/L chronic
⊗ CCME DW Guideline Max-4 ug/L USEPA

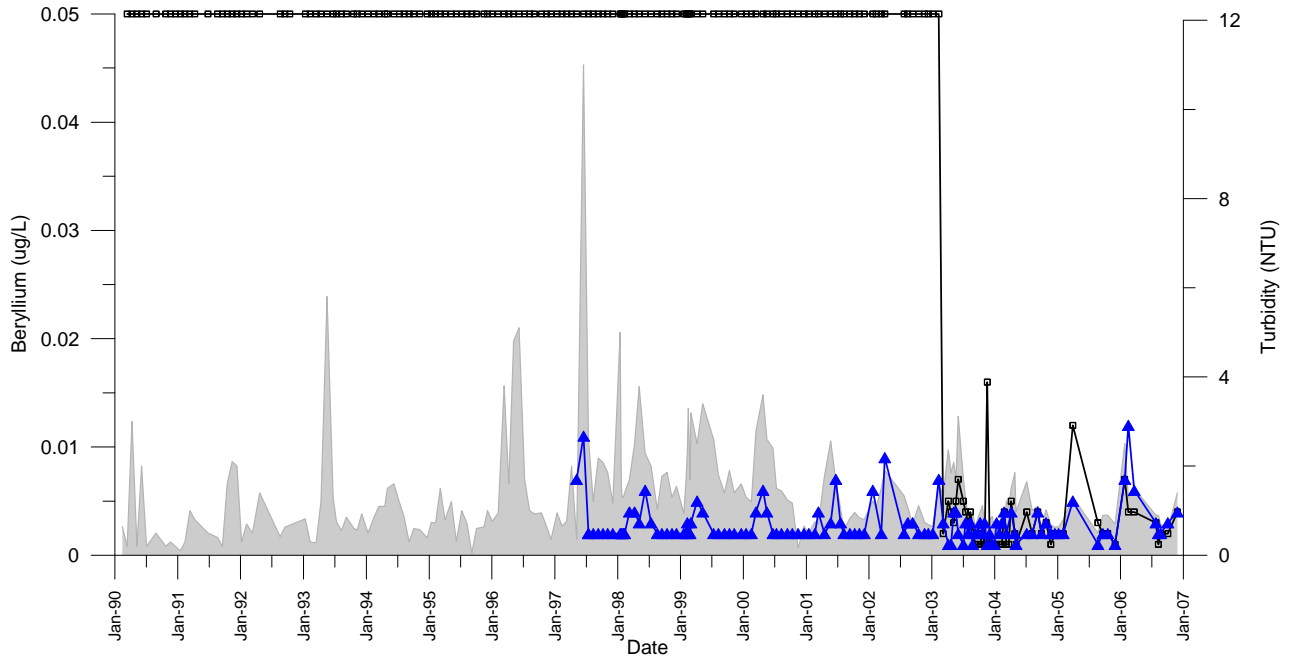
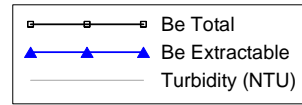


Figure 13
Pend D'Oreille River at Waneta
Bismuth Total and Extractable

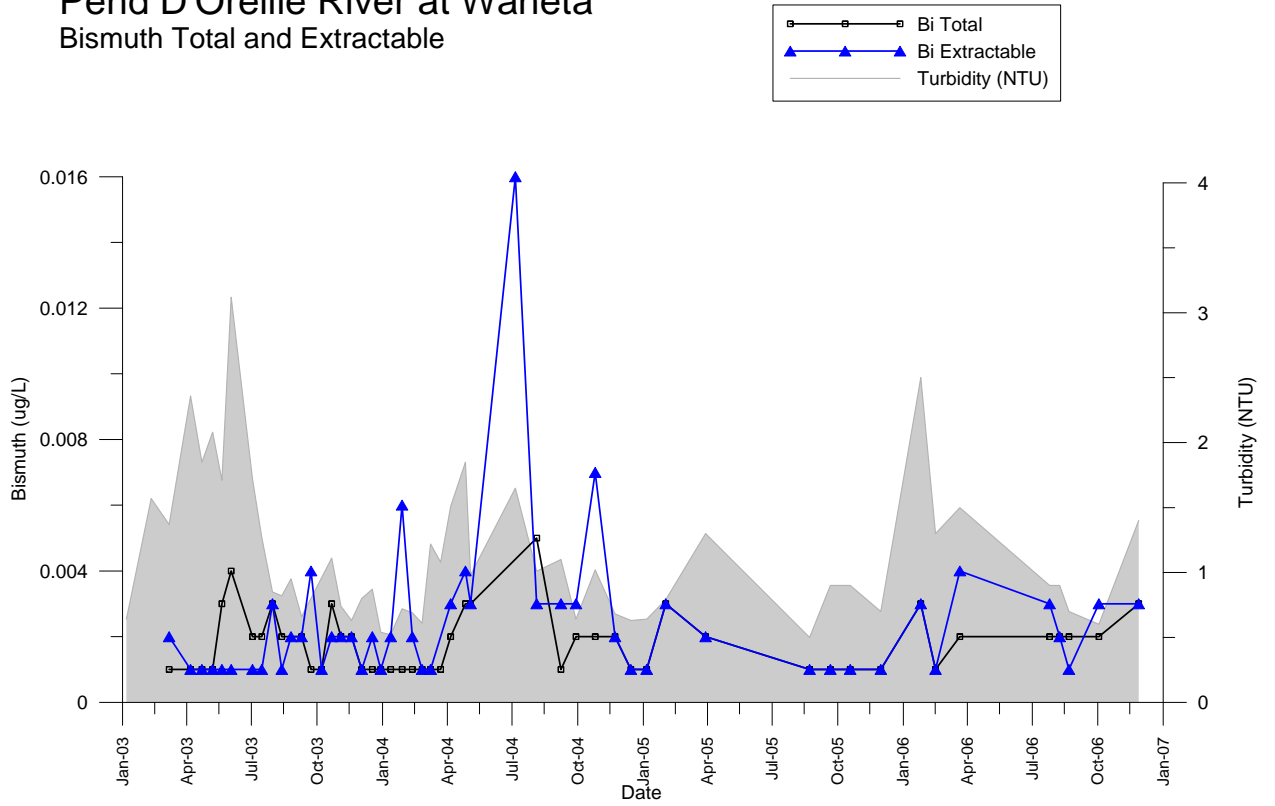


Figure 14
Pend D'Oreille River at Waneta
Bromide Dissolved

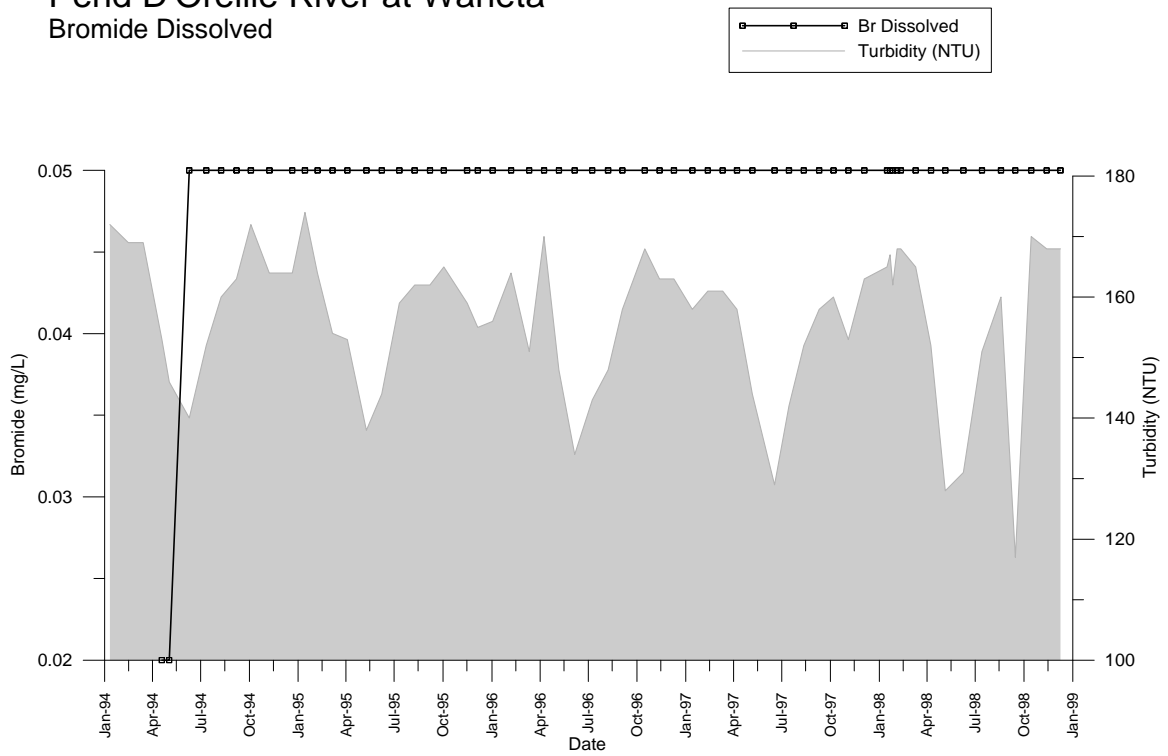


Figure 15
Pend D'Oreille River at Waneta
Carbon Dissolved Inorganic

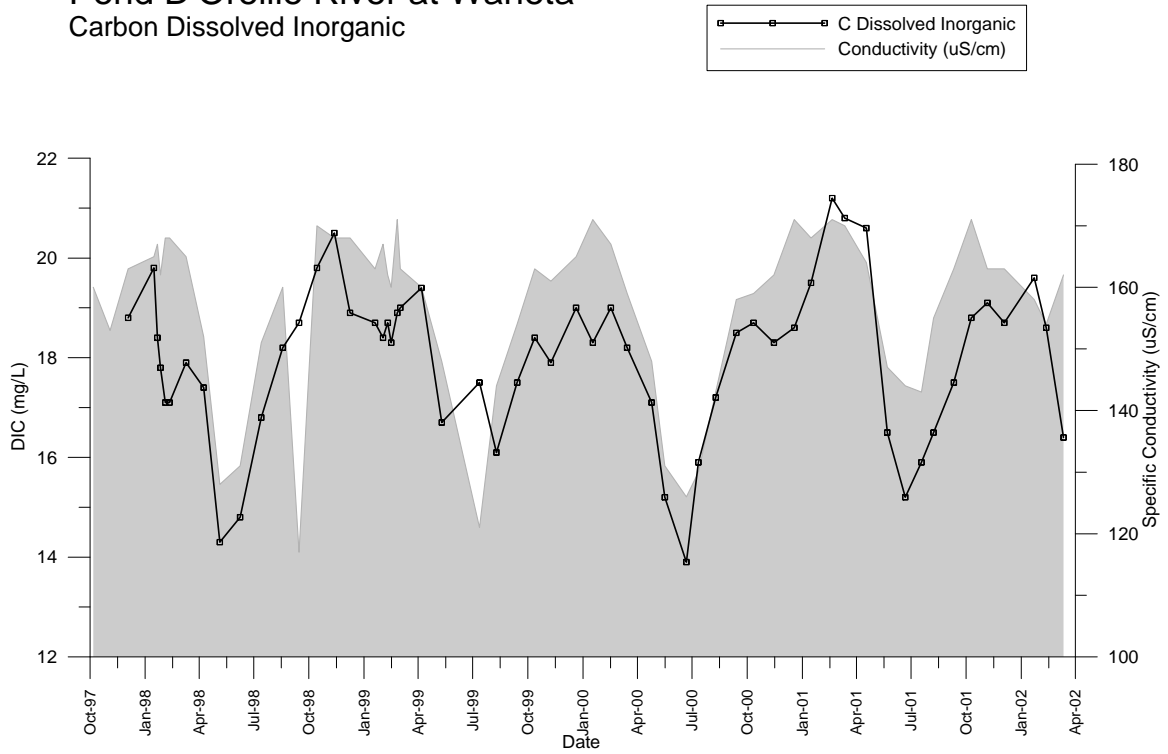


Figure 16
Pend D'Oreille River at Waneta
Carbon Dissolved Organic

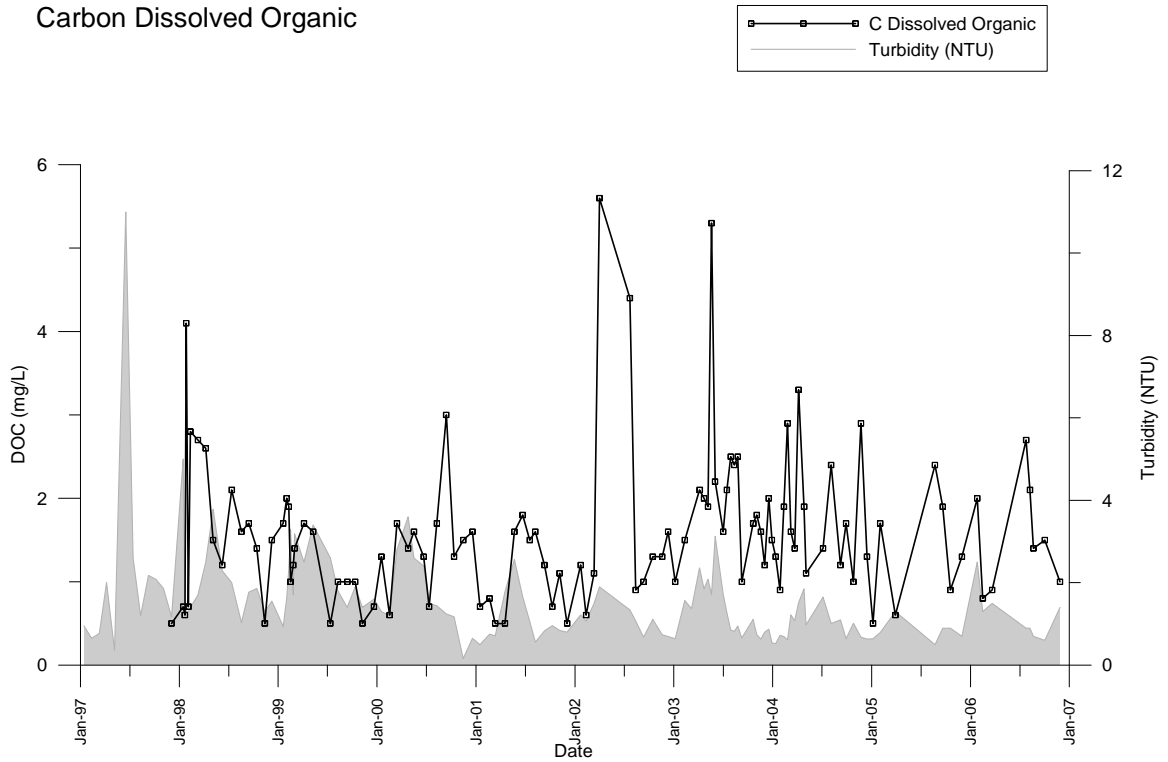


Figure 17
Pend D'Oreille River at Waneta
Calcium Dissolved and Extractable

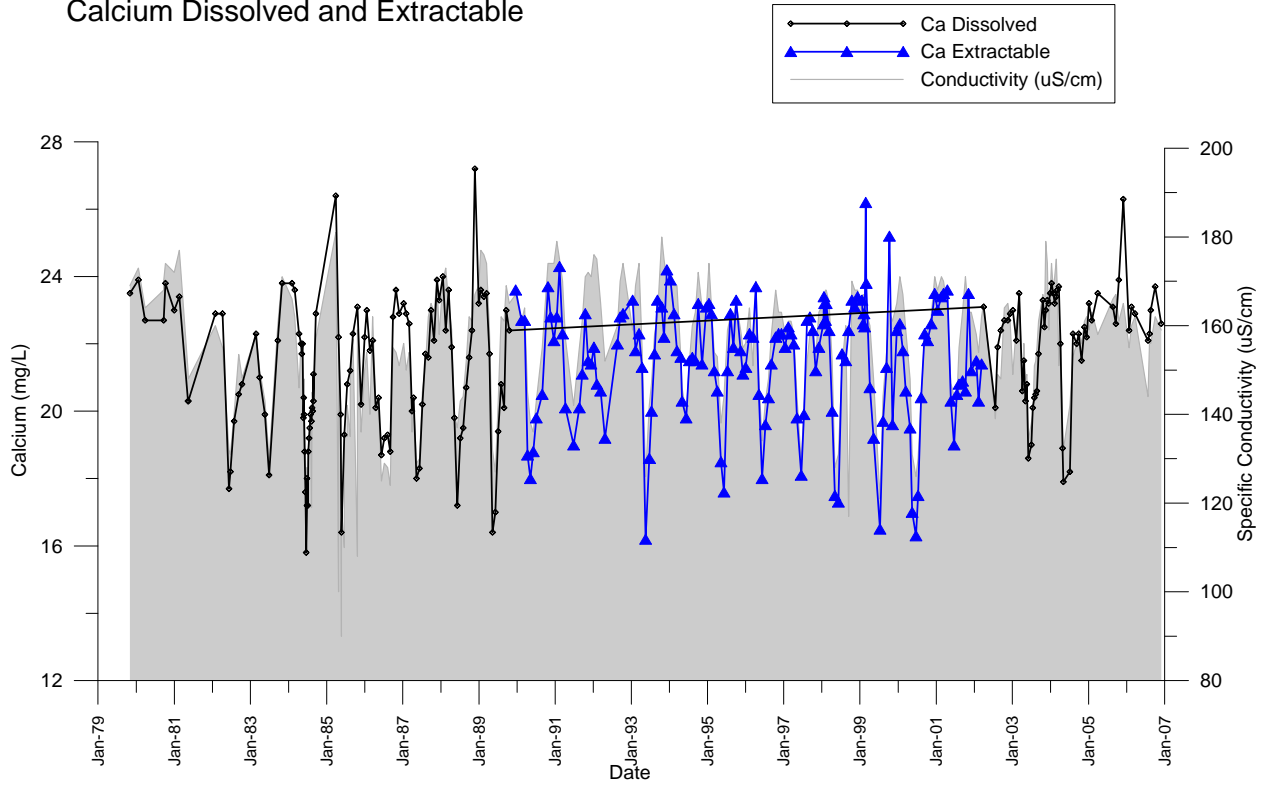


Figure 18
Pend D'Oreille River at Waneta
Cadmium Total and Extractable

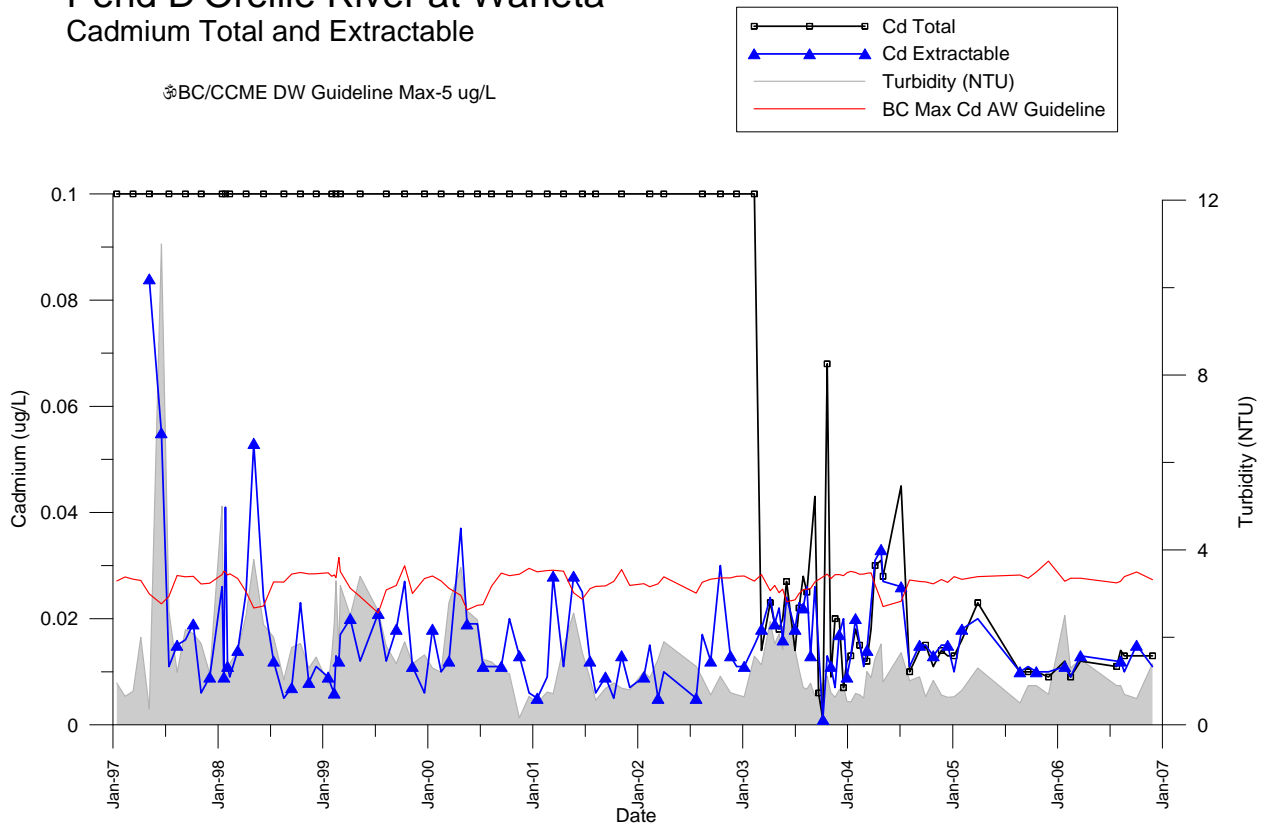


Figure 19
Pend D'Oreille River at Waneta
Cadmium Total and Extractable

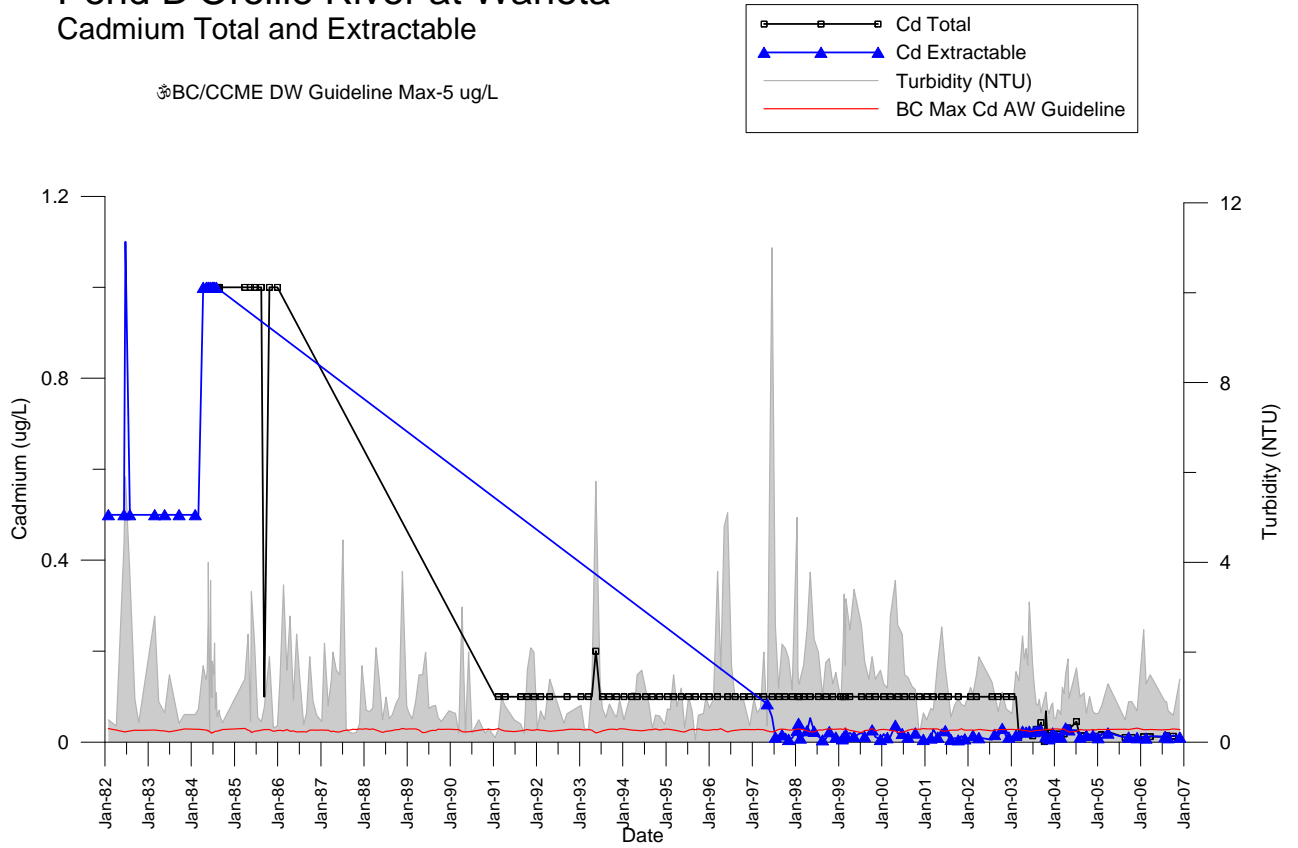


Figure 20
Pend D'Oreille River at Waneta
Chloride Dissolved

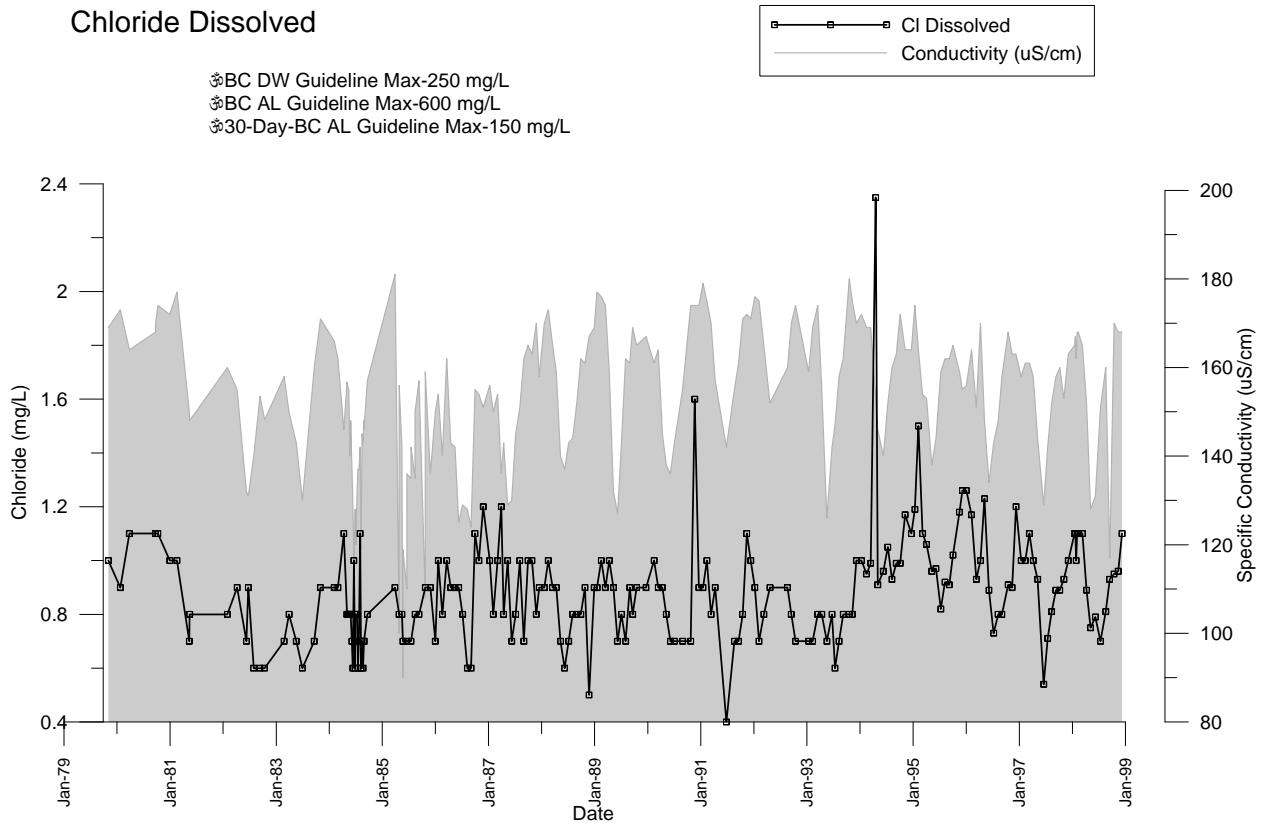


Figure 21
Pend D'Oreille River at Waneta
Cobalt Total and Extractable

⊗ BC AL Guideline Max-110 ug/L
⊗ 30-Day-BC AL Guideline Max-4 ug/L

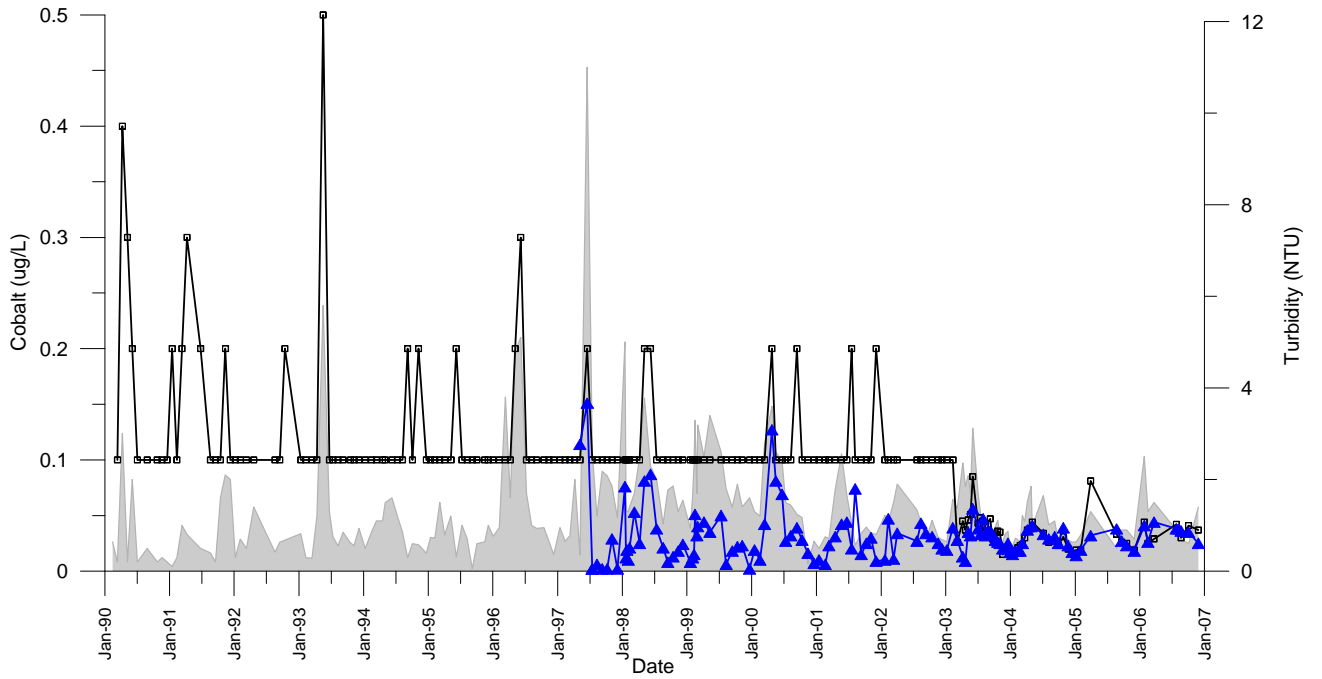
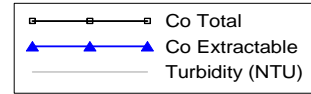


Figure 22
Pend D'Oreille River at Waneta
Colour Apparent and True

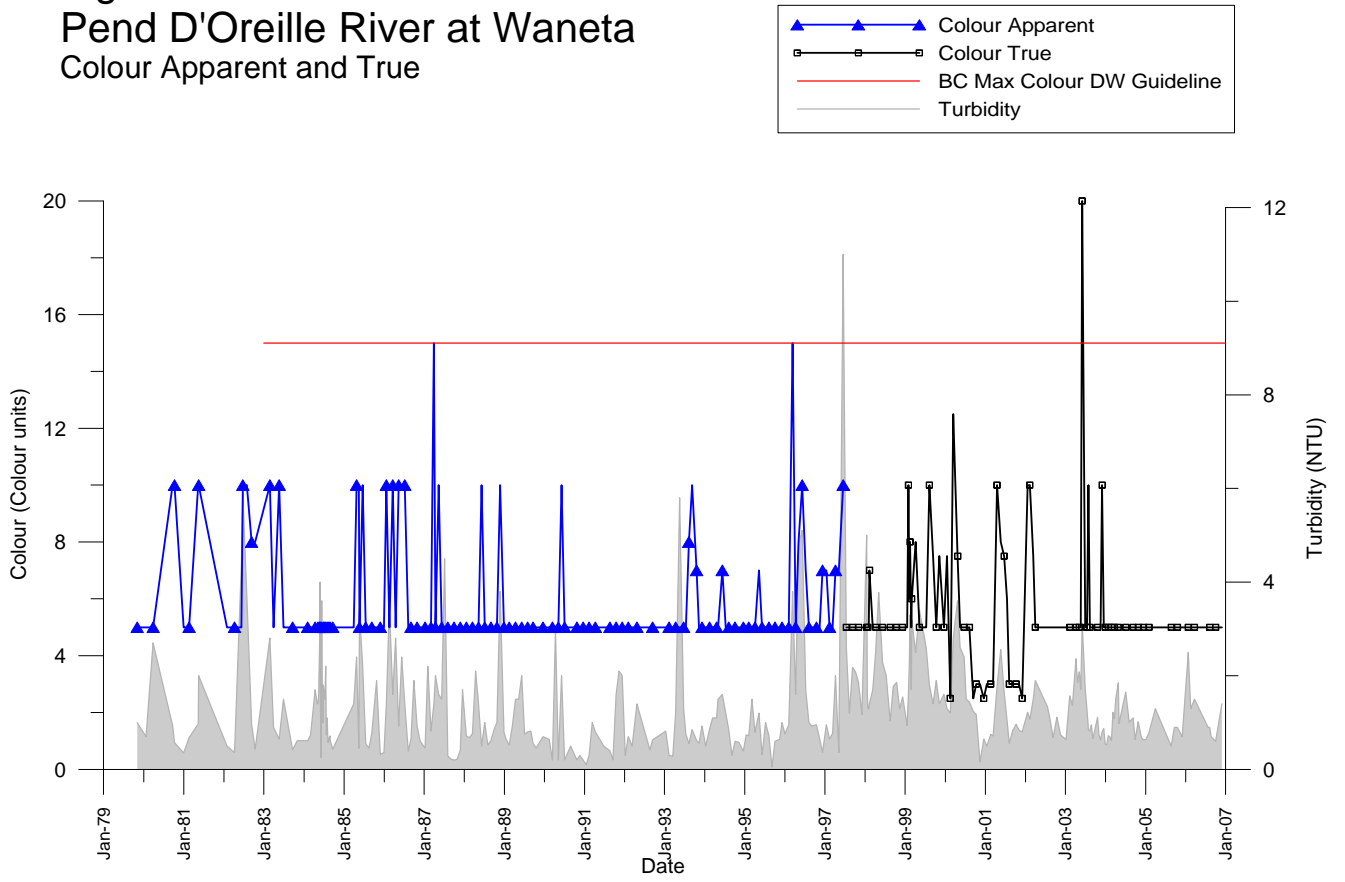


Figure 23
Pend D'Oreille River at Waneta
Chromium Total and Extractable (2001 - 2006)

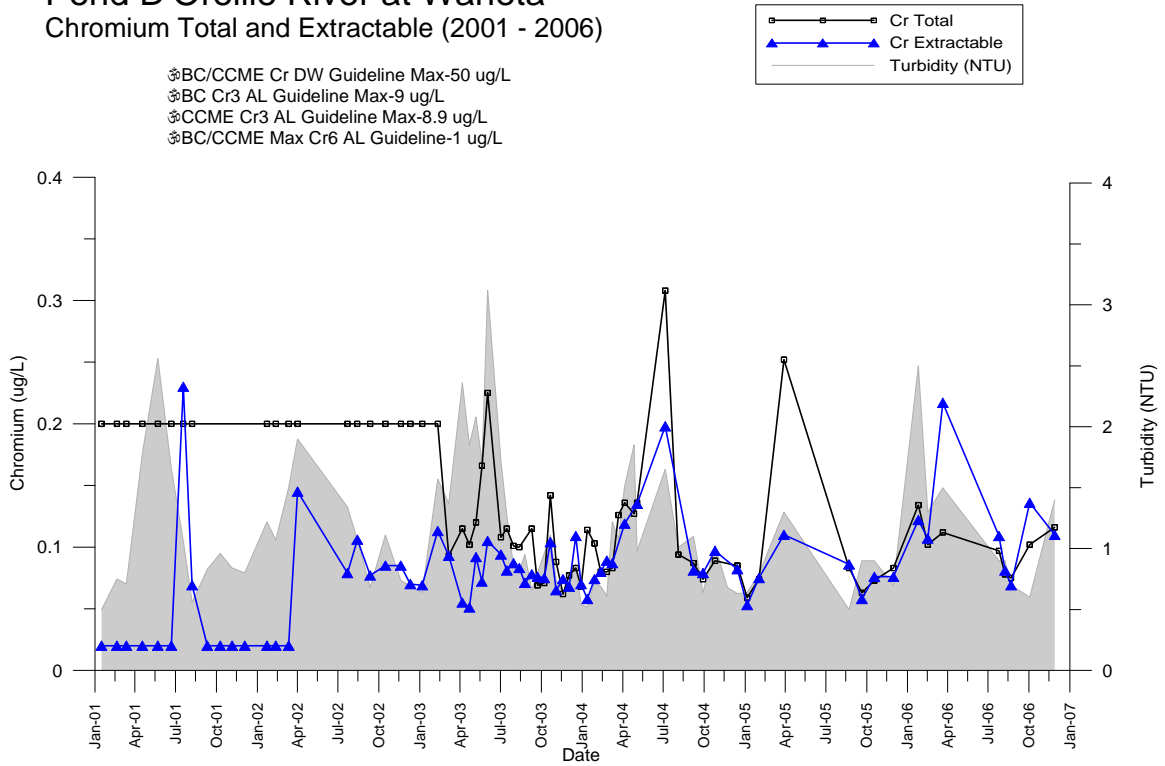


Figure 24
Pend D'Oreille River at Waneta
Chromium Total and Extractable (1991 - 2006)

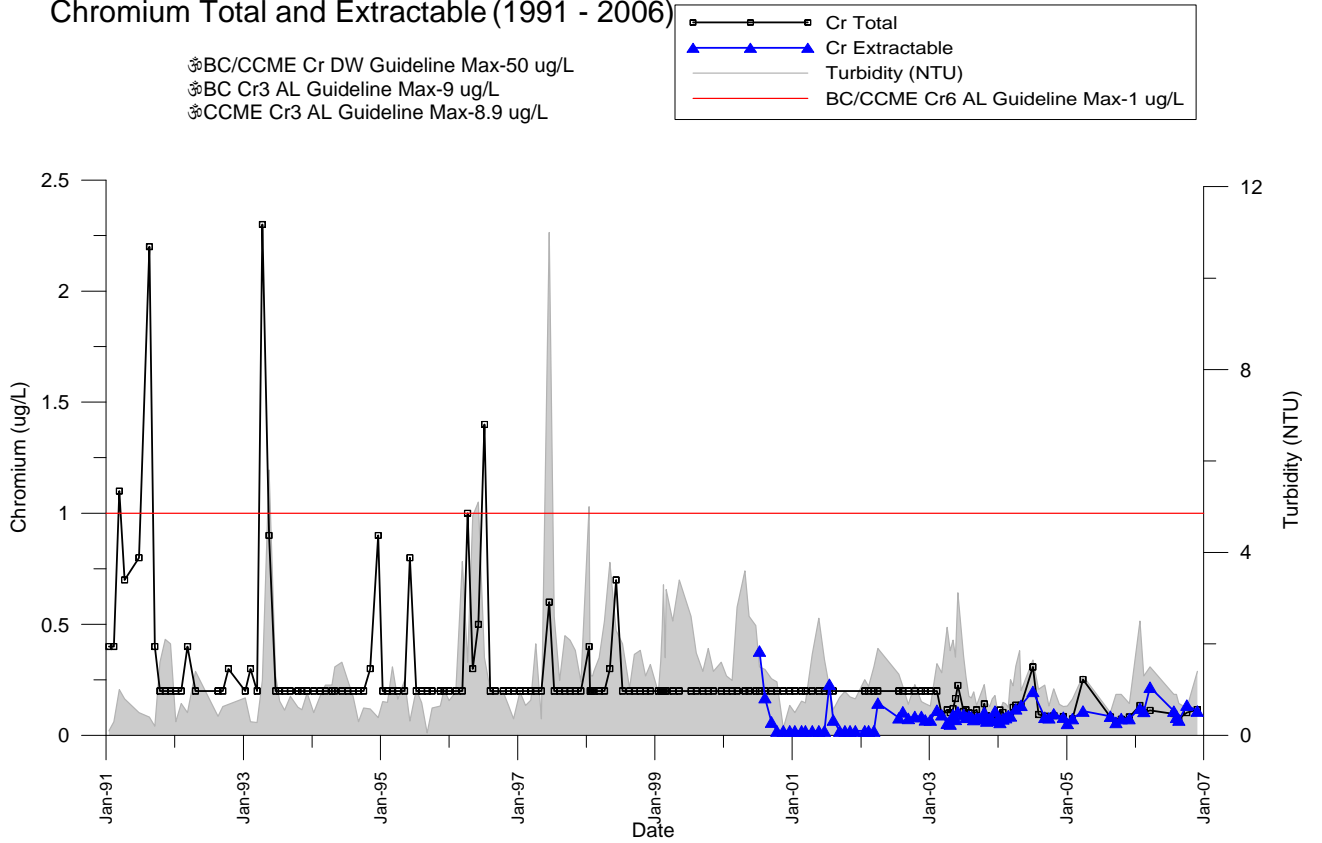


Figure 25
Pend D'Oreille River at Waneta
Copper Total and Extractable (1982 - 2006)

⊗ BC Max Cu DW Guideline 500 ug/L
 ⊗ BC Cu AL Guideline Range 7.13-10.88 ug/L
 ⊗ CCME Max Cu AL Guideline Range 2-22.63 ug/L

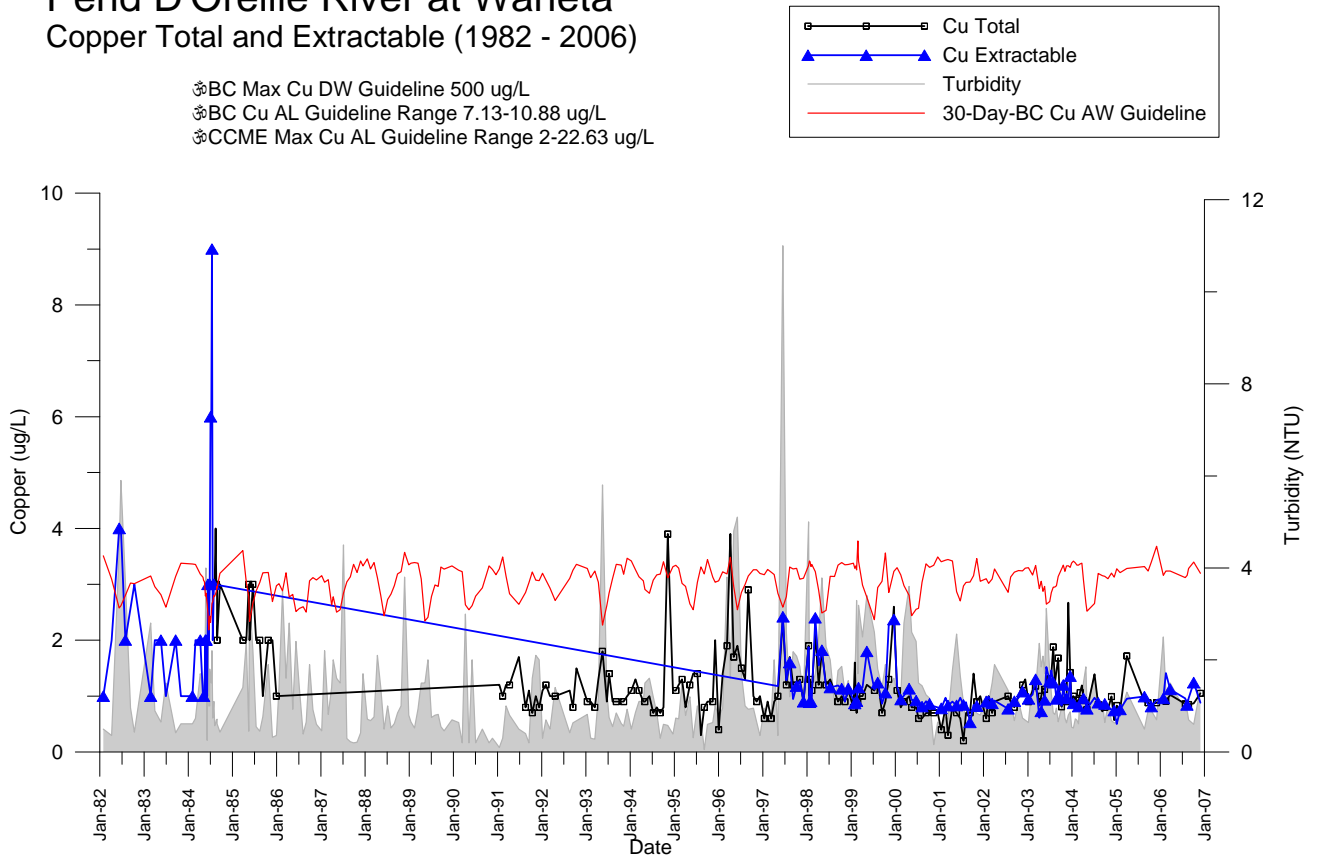


Figure 26
Pend D'Oreille River at Waneta
Fluoride Total and Dissolved

⊗ BC/CCME DW Guideline Max-1.5 mg/L
 ⊗ BC-30-Day DW Guideline Max-1 mg/L

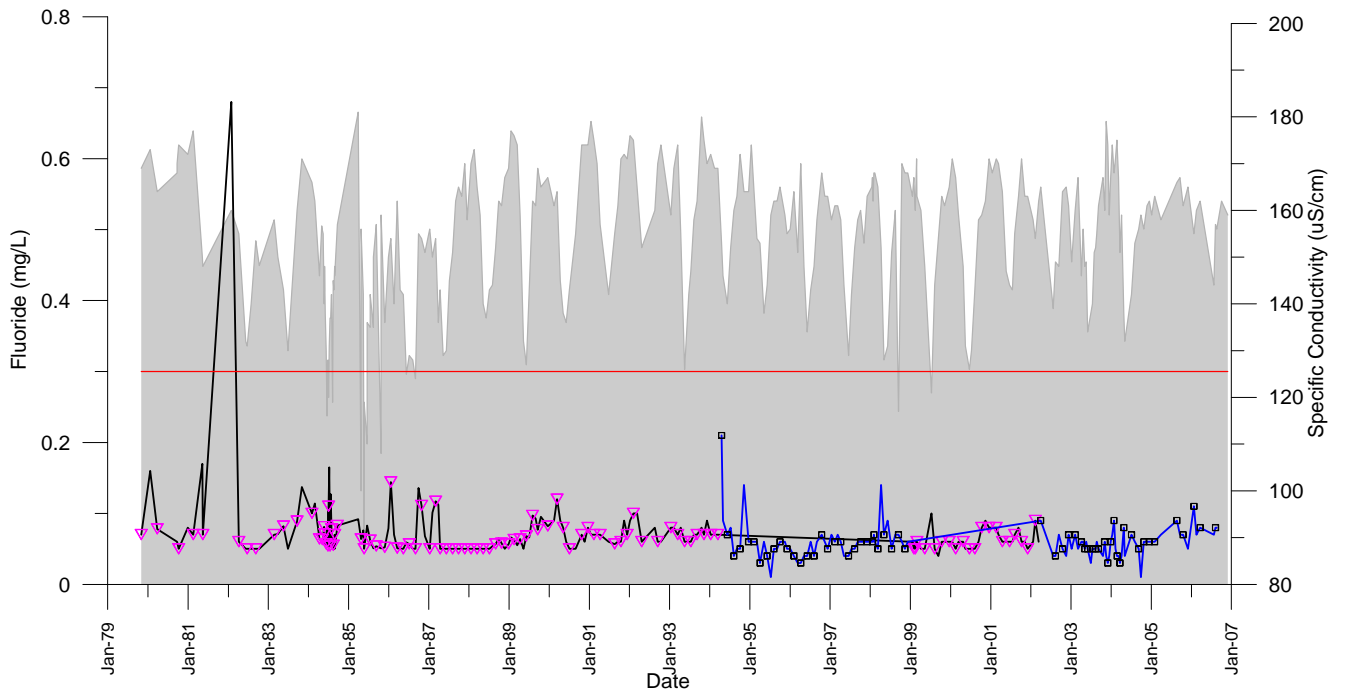
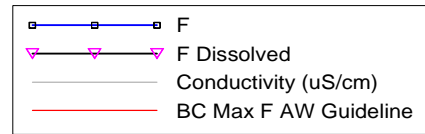


Figure 27
Pend D'Oreille River at Waneta
Iron Total and Extractable

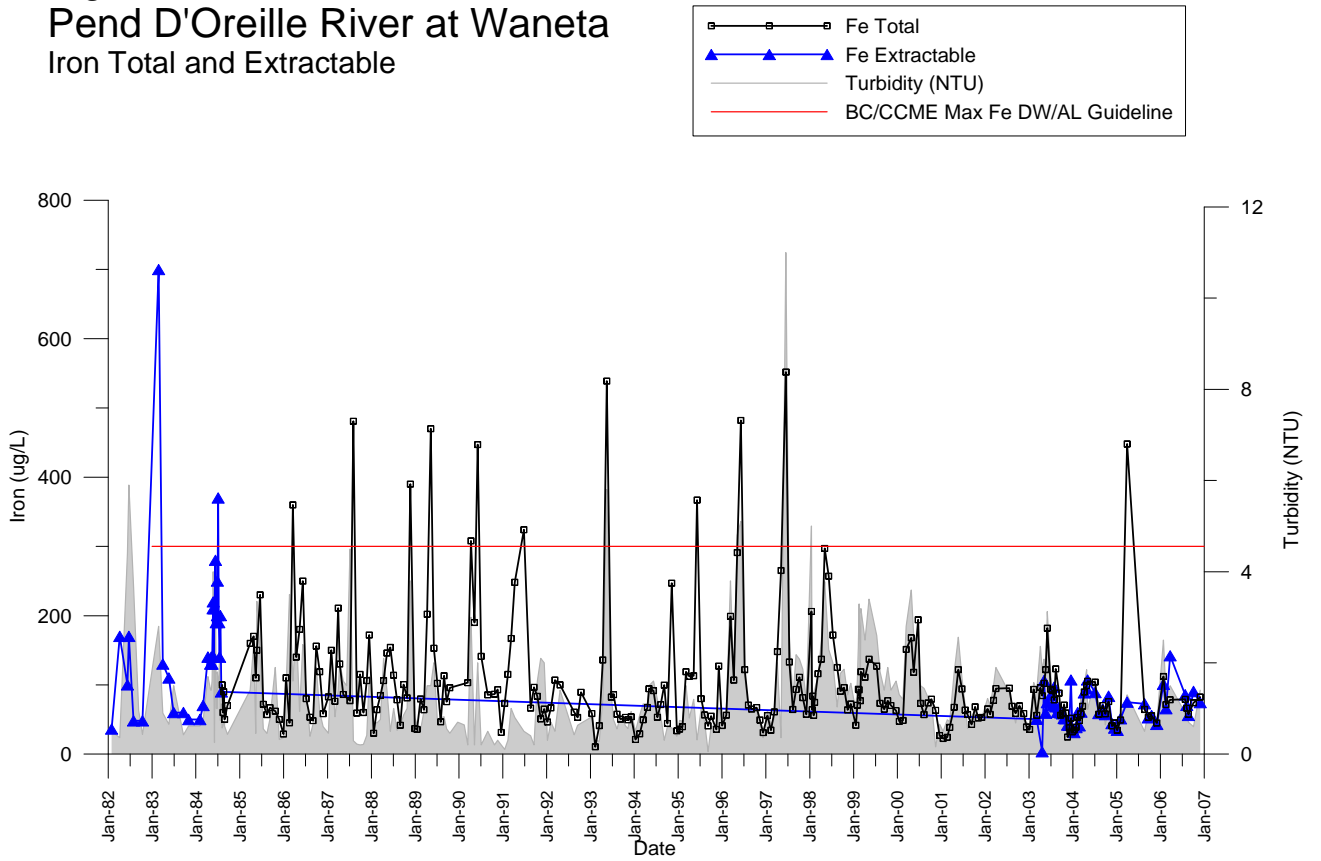


Figure 28
Pend D'Oreille River at Waneta
Coliforms Fecal

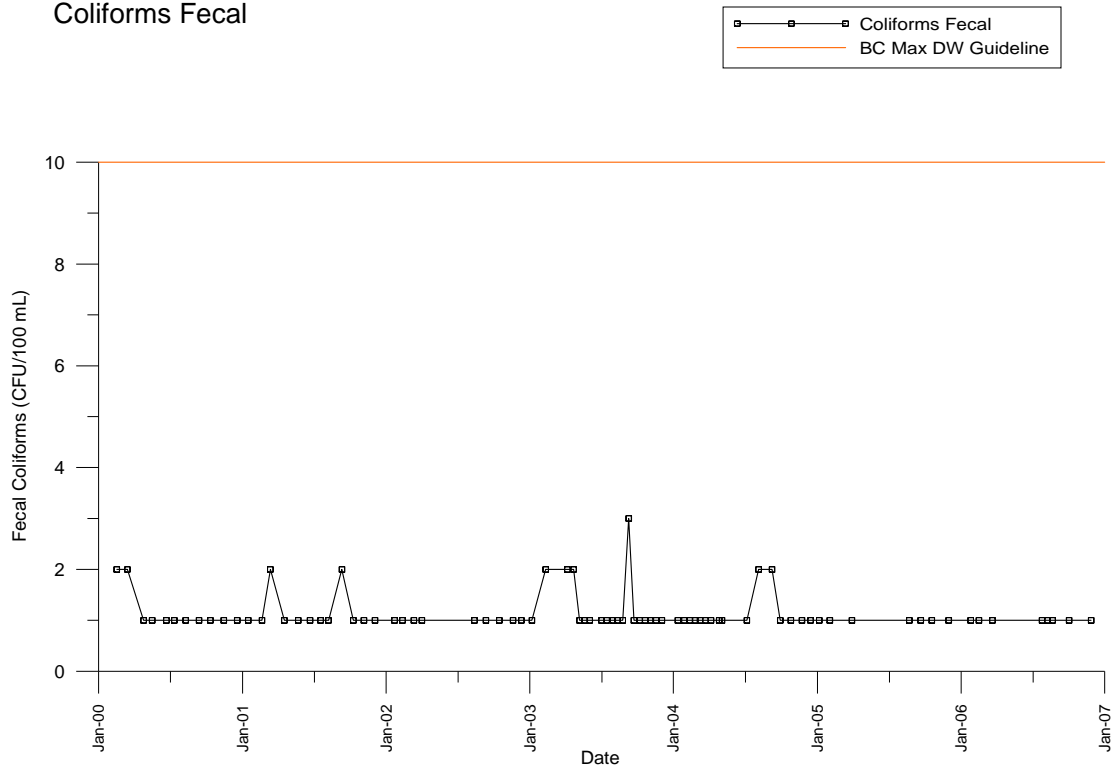


Figure 29
Pend D'Oreille River at Waneta
Gallium Total and Extractable

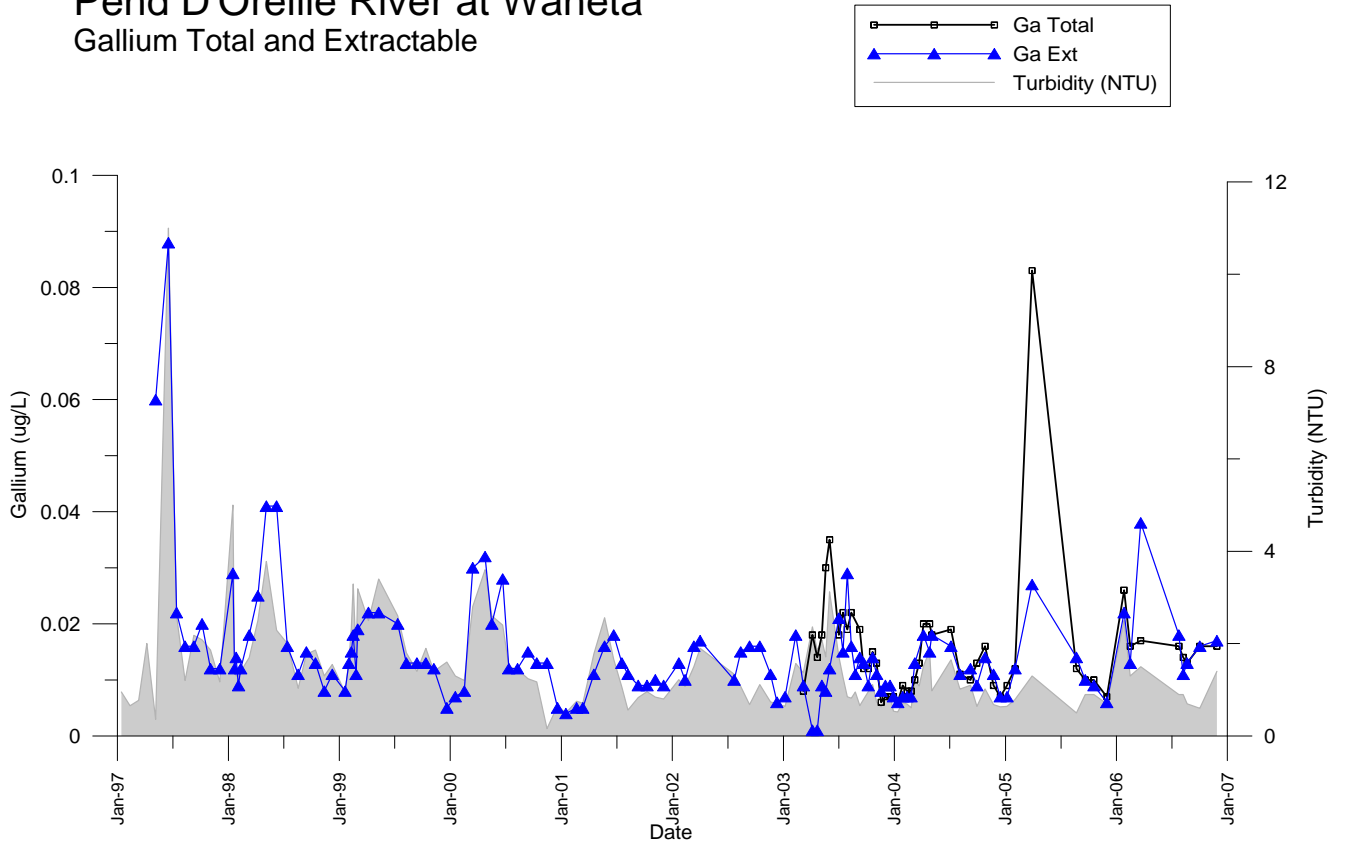


Figure 30
Pend D'Oreille River at Waneta
Hardness Total

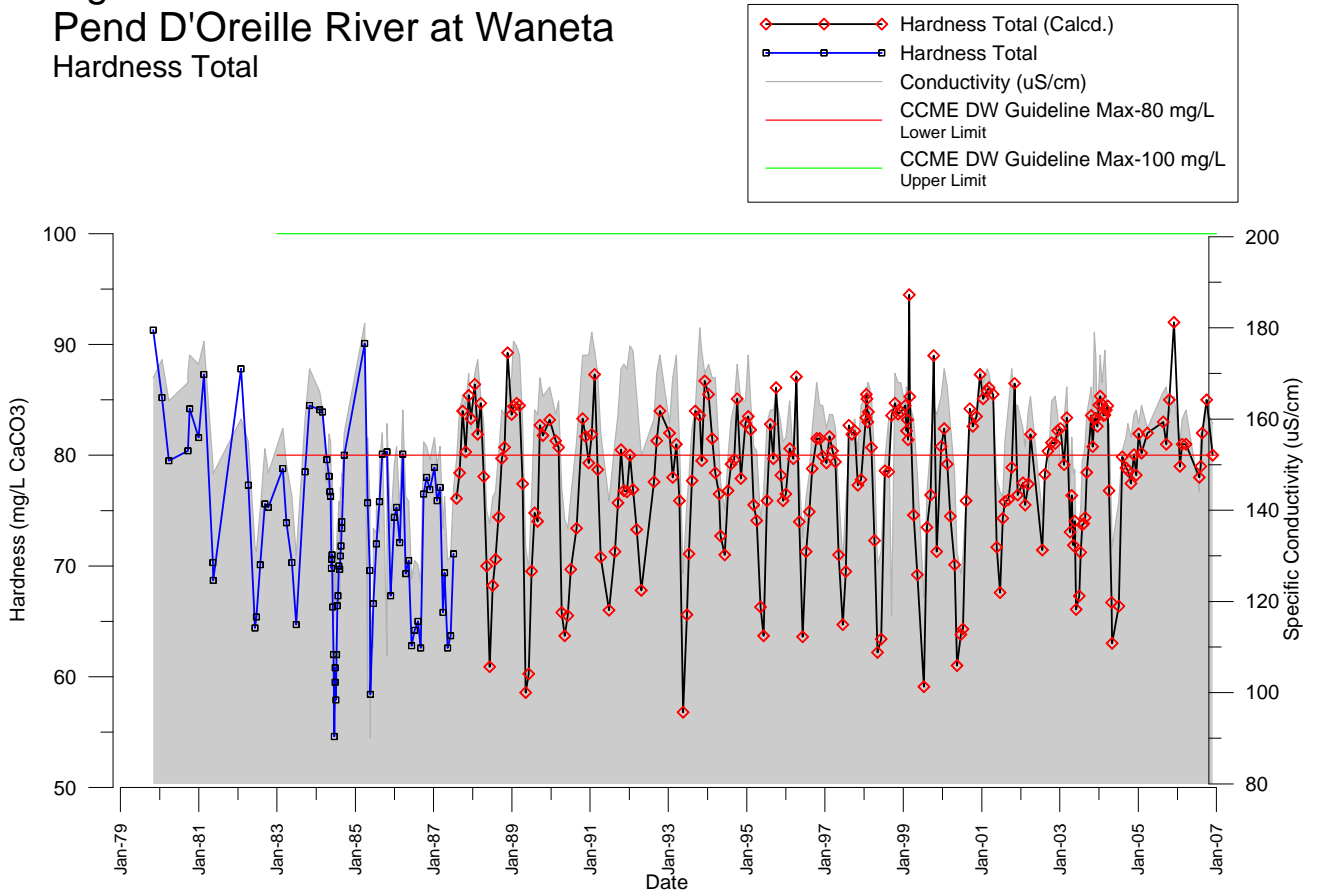


Figure 31
Pend D'Oreille River at Waneta
Potassium Dissolved and Extractable

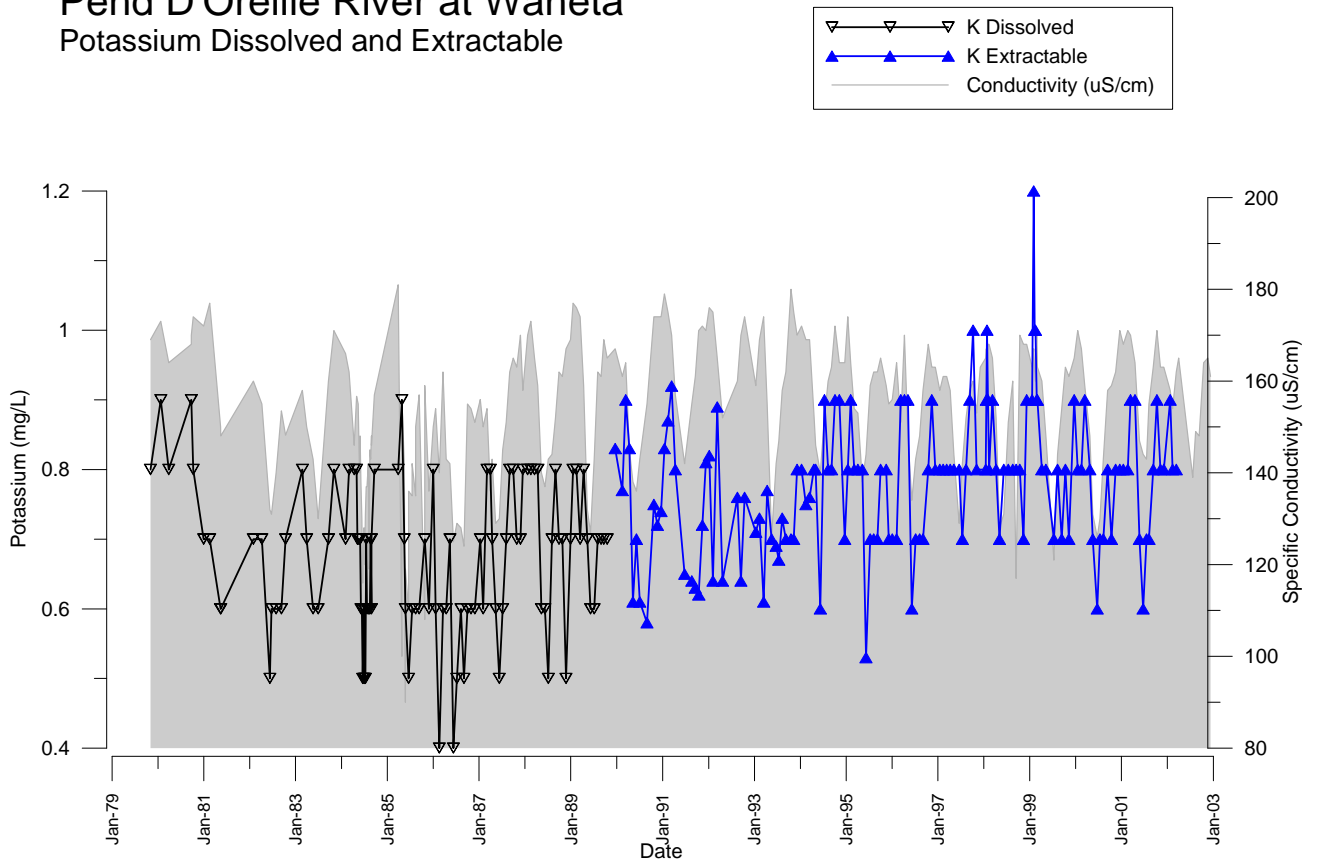


Figure 32
Pend D'Oreille River at Waneta
Lanthanum Total and Extractable

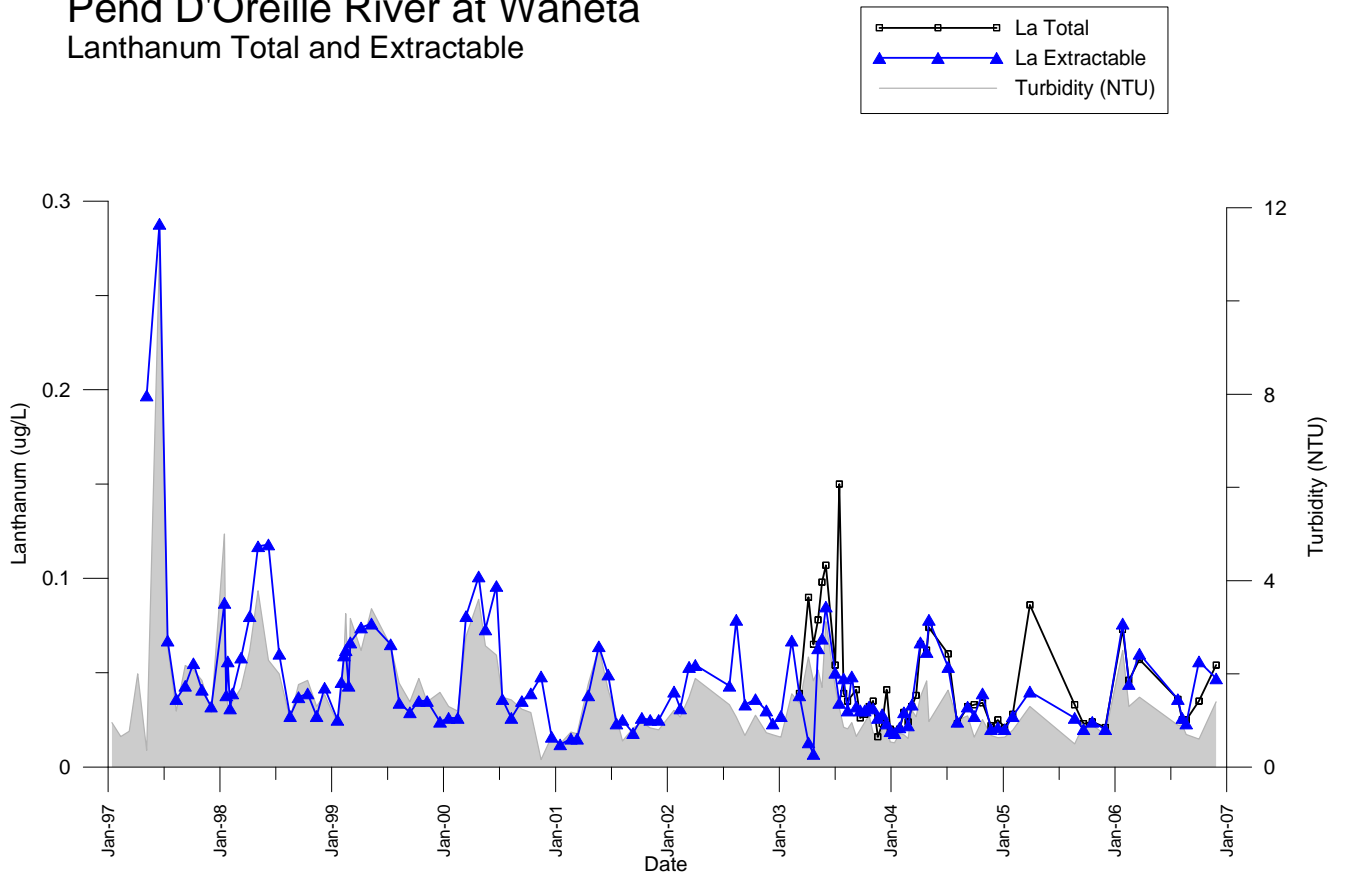


Figure 33
Pend D'Oreille River at Waneta
Lead Total and Extractable

⊕ BC DW Guideline Max-50 ug/L
 ⊕ CCME DW Guideline Max-10 ug/L
 ⊕ BC Max AL Guideline Range 37.79-75.97 ug/L

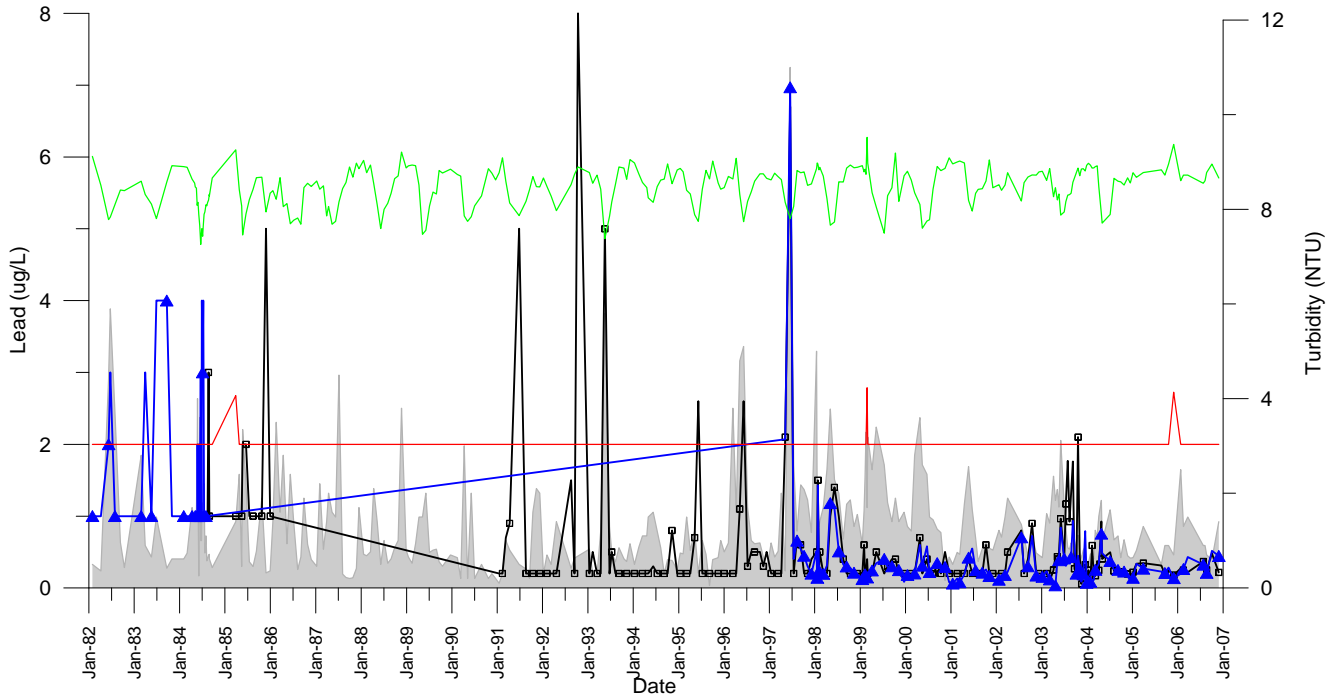
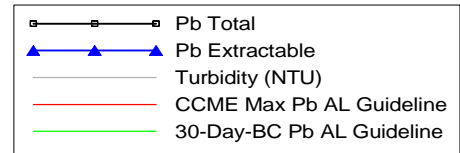


Figure 34
Pend D'Oreille River at Waneta
Lithium versus Turbidity

BC AL Guideline Max-5000 ug/L

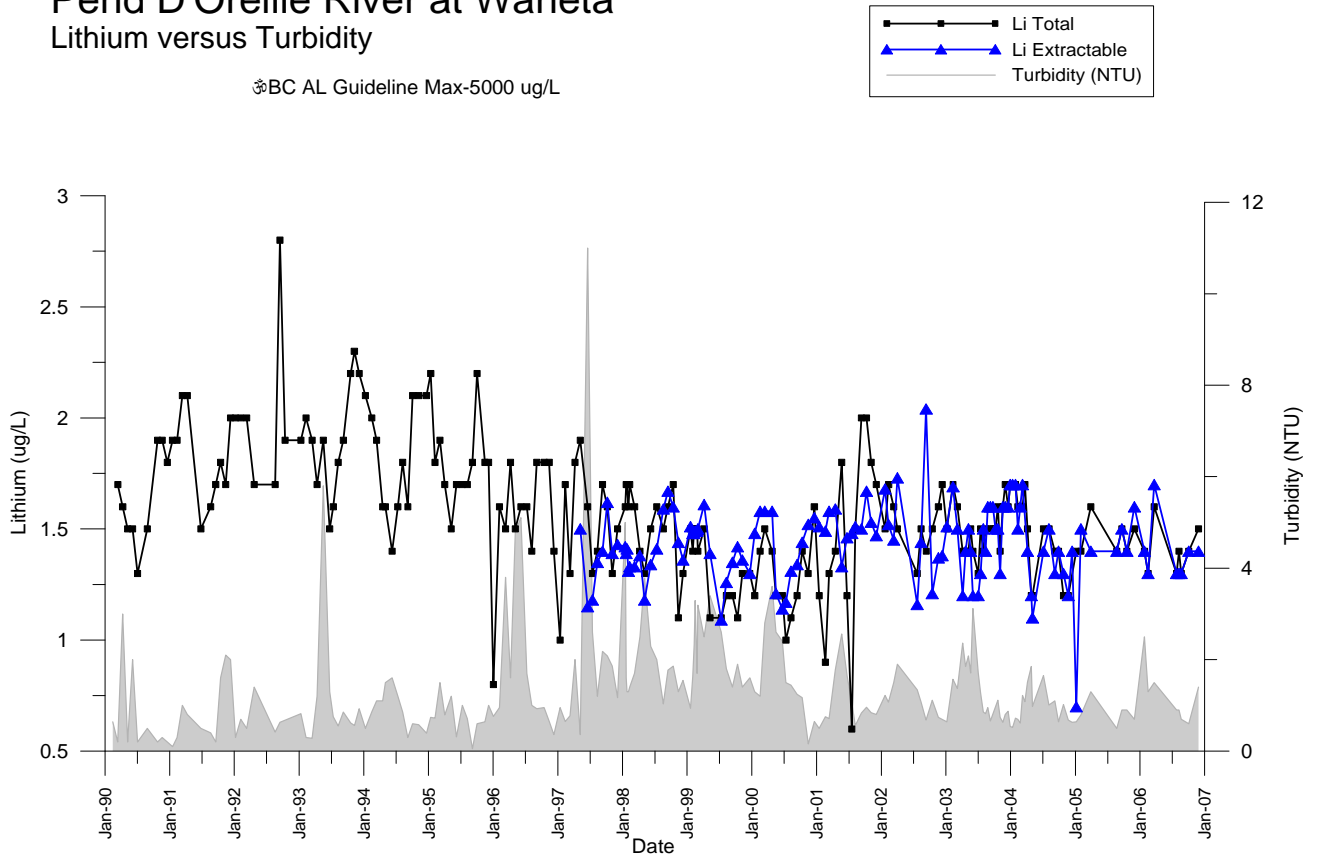


Figure 35
Pend D'Oreille River at Waneta
 Lithium versus Specific Conductivity

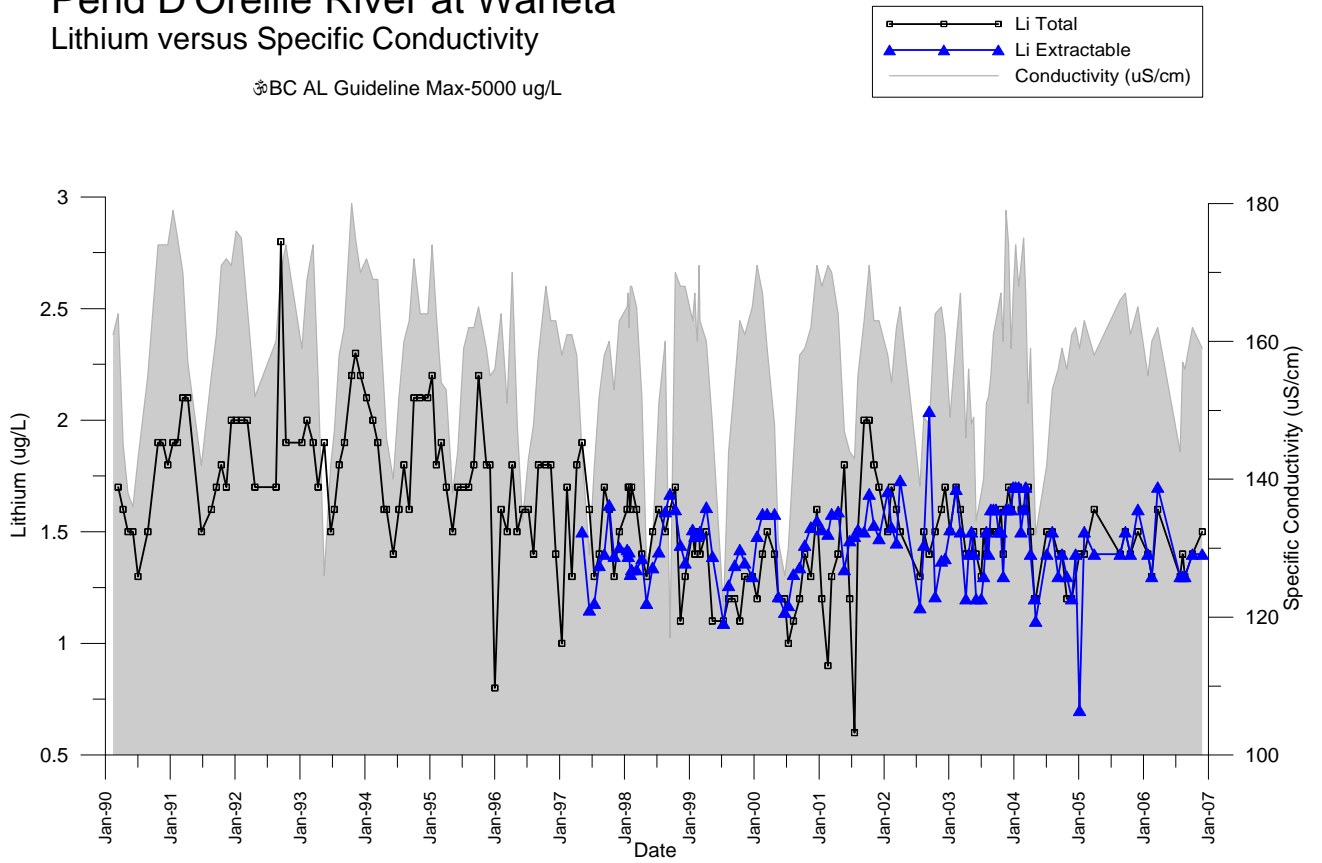


Figure 36
 Pend D'Oreille River at Waneta
 Magnesium Dissolved and Extractable

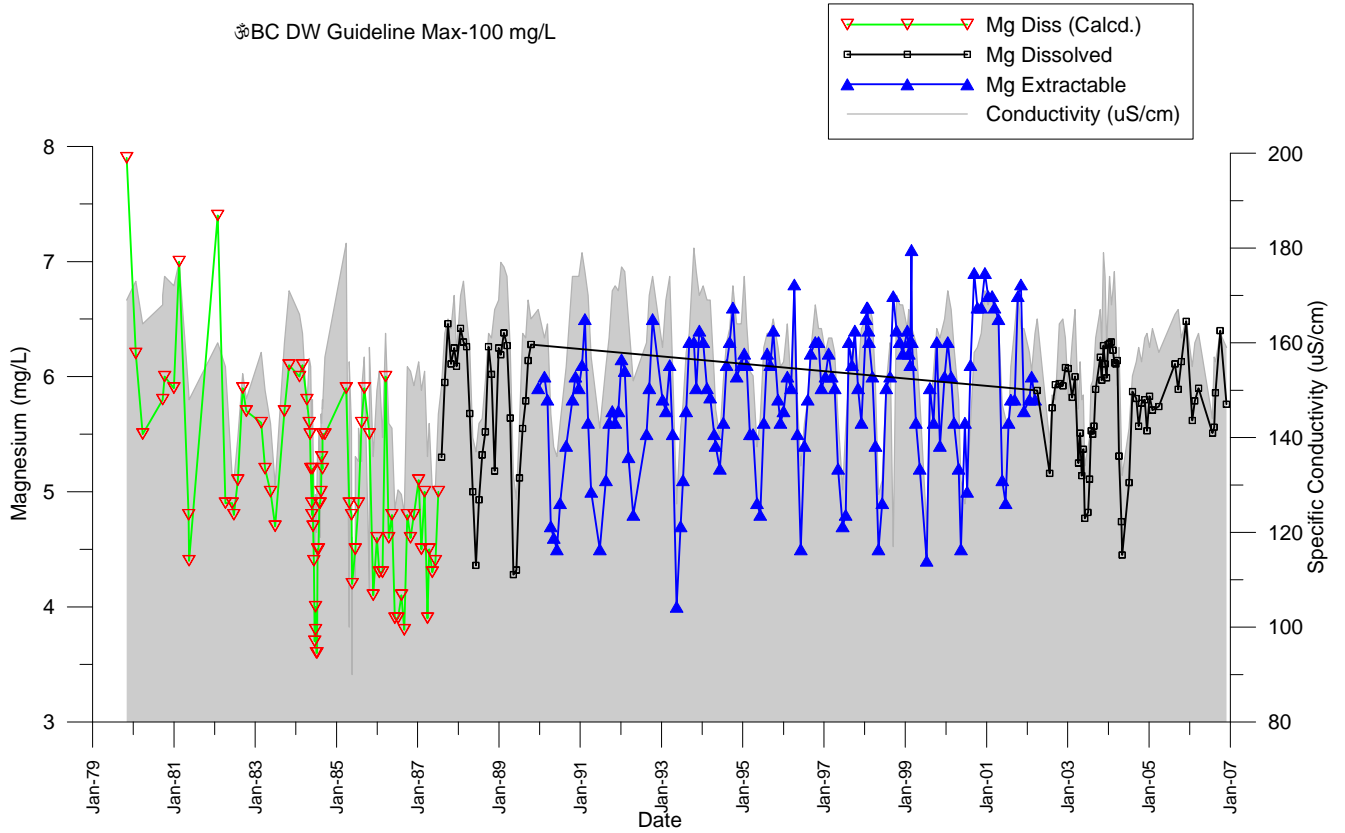


Figure 37
Pend D'Oreille River at Waneta
Manganese Total and Extractable

⊗ BC Max Mn AL Guideline Range 1141.69-1581.39 ug/L
⊗ 30-Day-BC Mn AL Guideline Range 845.24-1020.8 ug/L

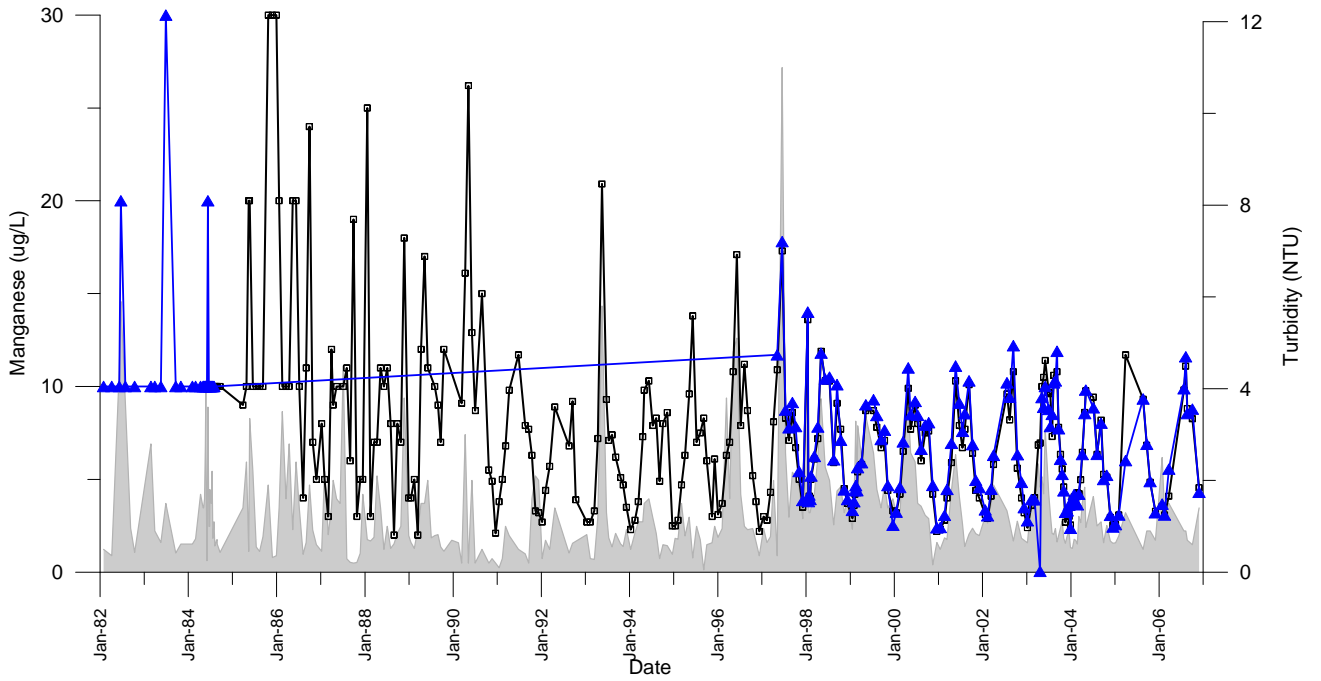
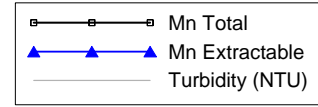


Figure 38
Pend D'Oreille River at Waneta
Molybdenum Total and Extractable

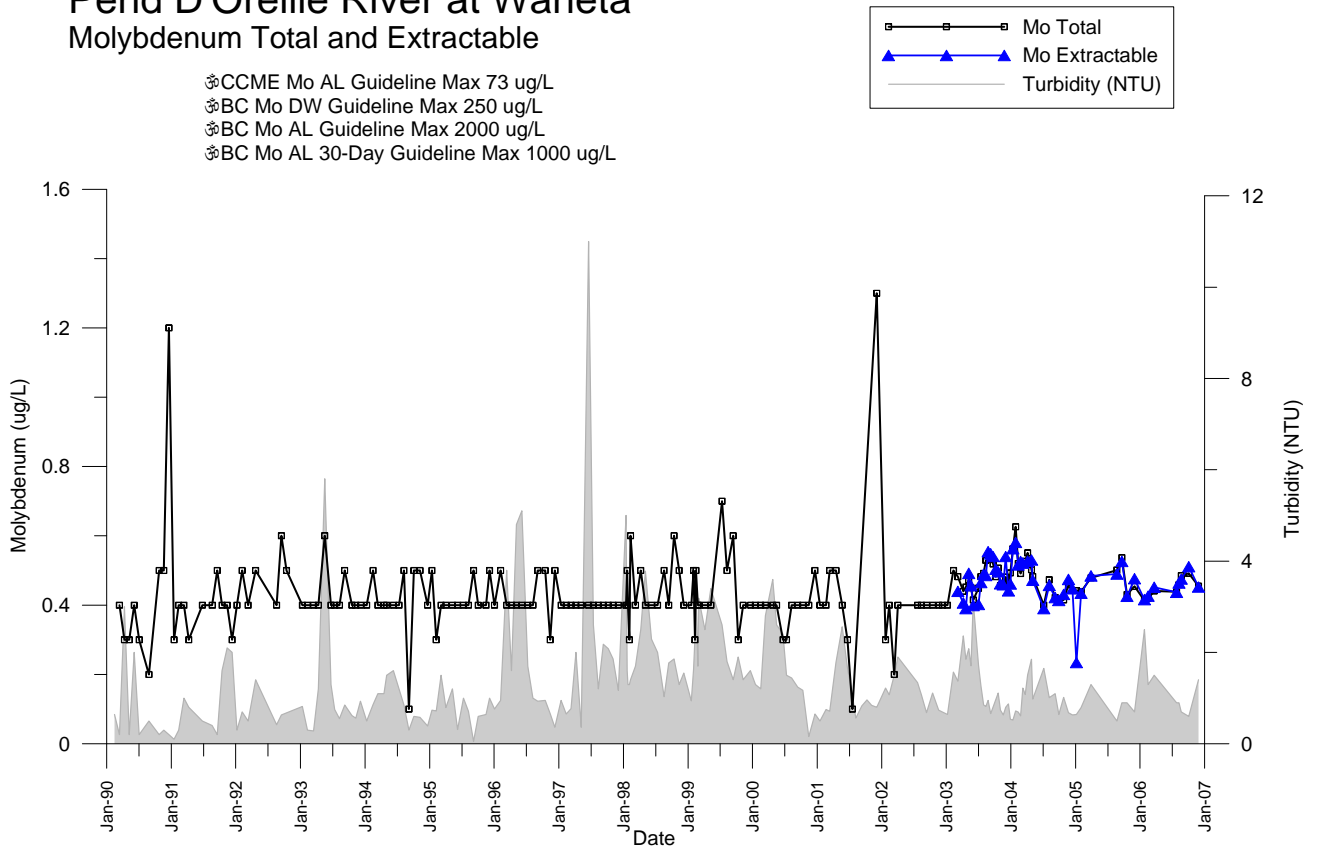


Figure 39
Pend D'Oreille River at Waneta
Nitrogen Dissolved Nitrate

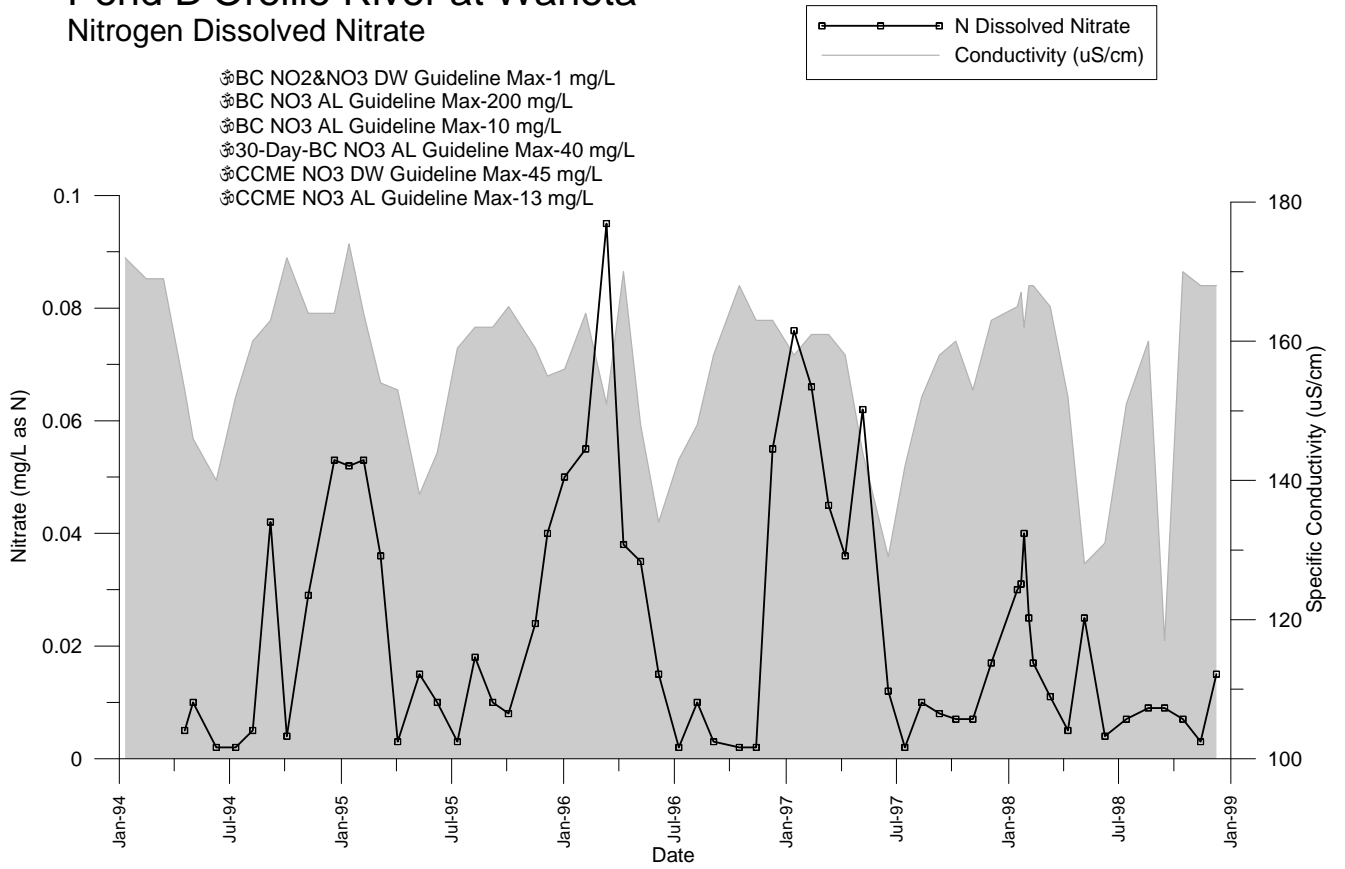


Figure 40
Pend D'Oreille River at Waneta
Nitrogen Dissolved NO3 and NO2

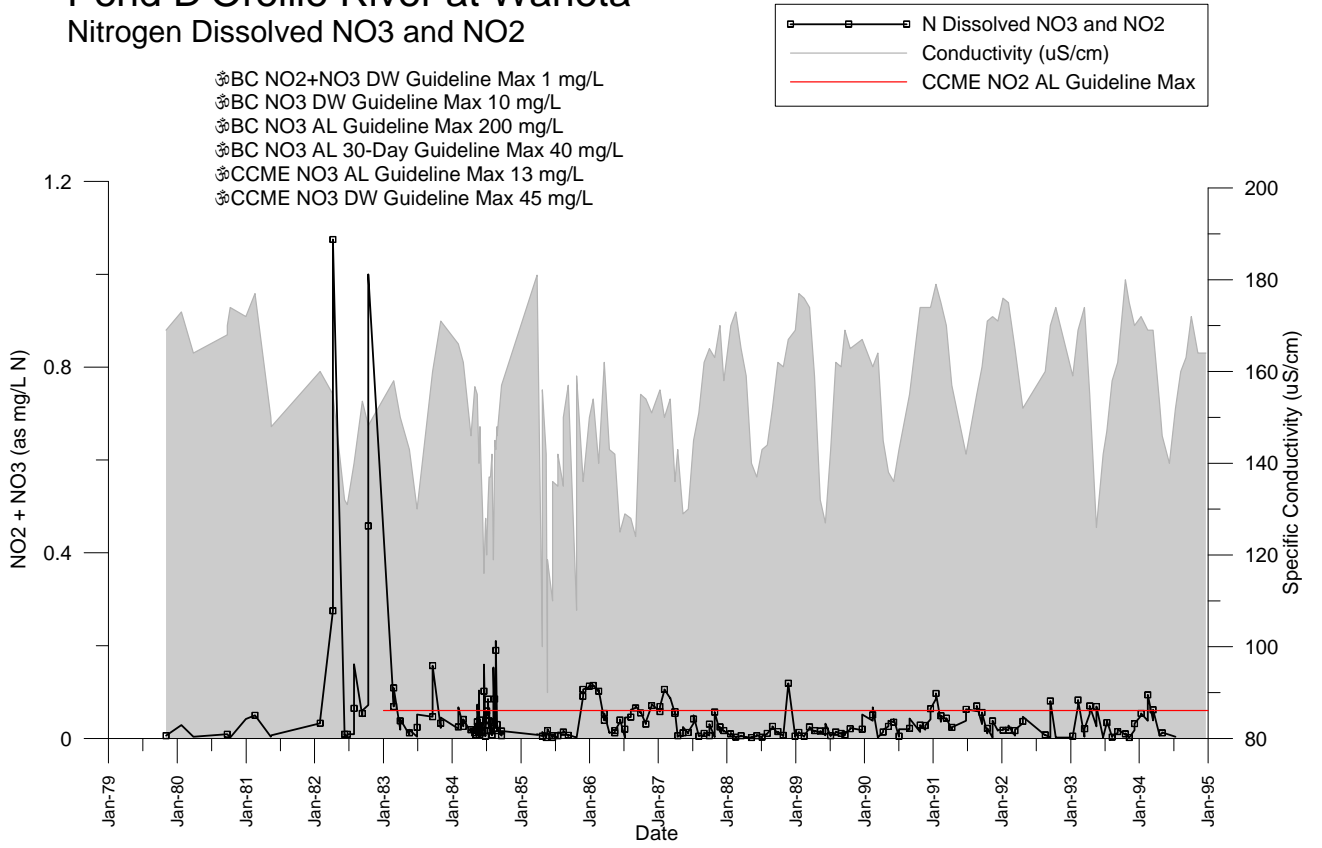


Figure 41
Pend D'Oreille River at Waneta
Nitrogen Nitrite

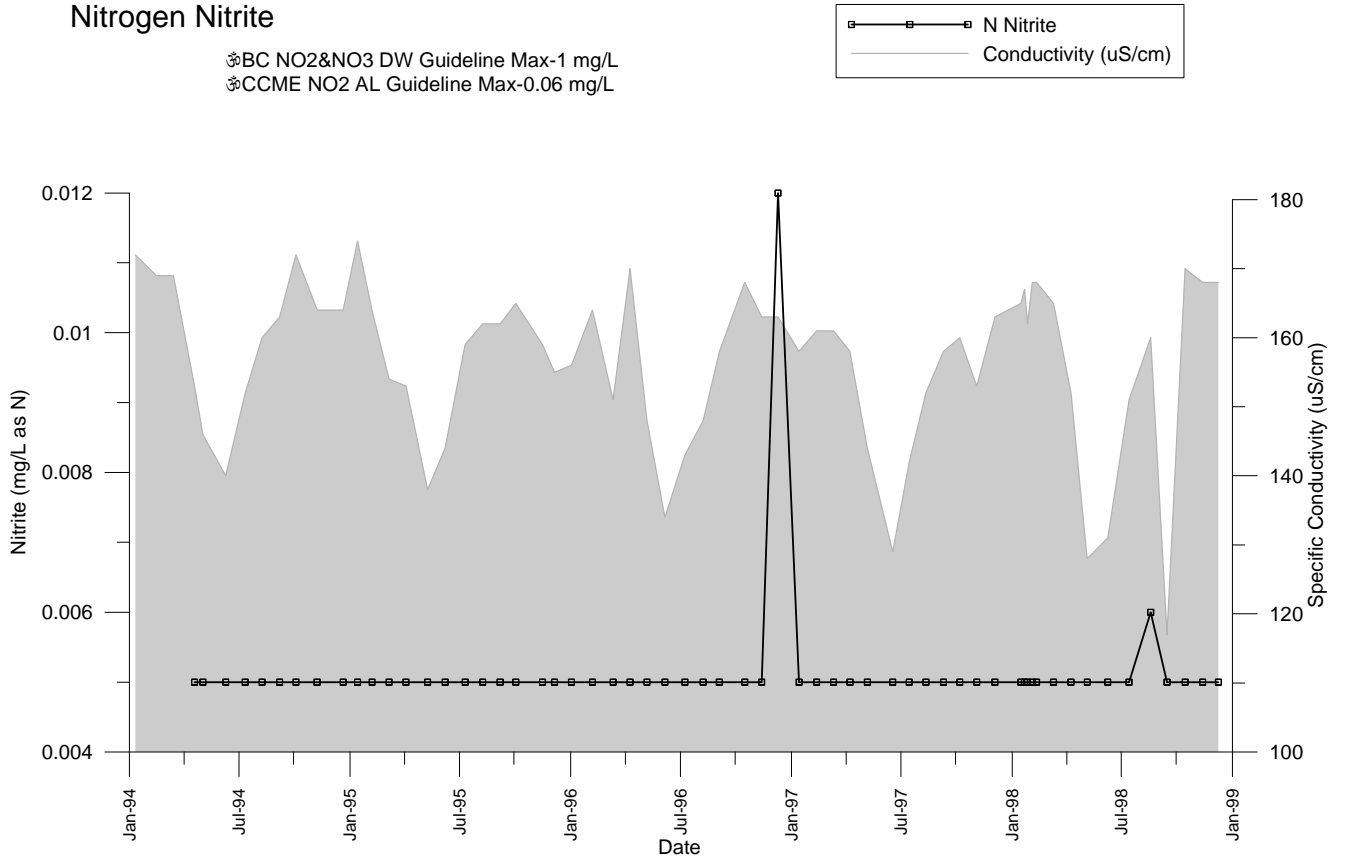


Figure 42
Pend D'Oreille River at Waneta
Nitrogen Total Dissolved

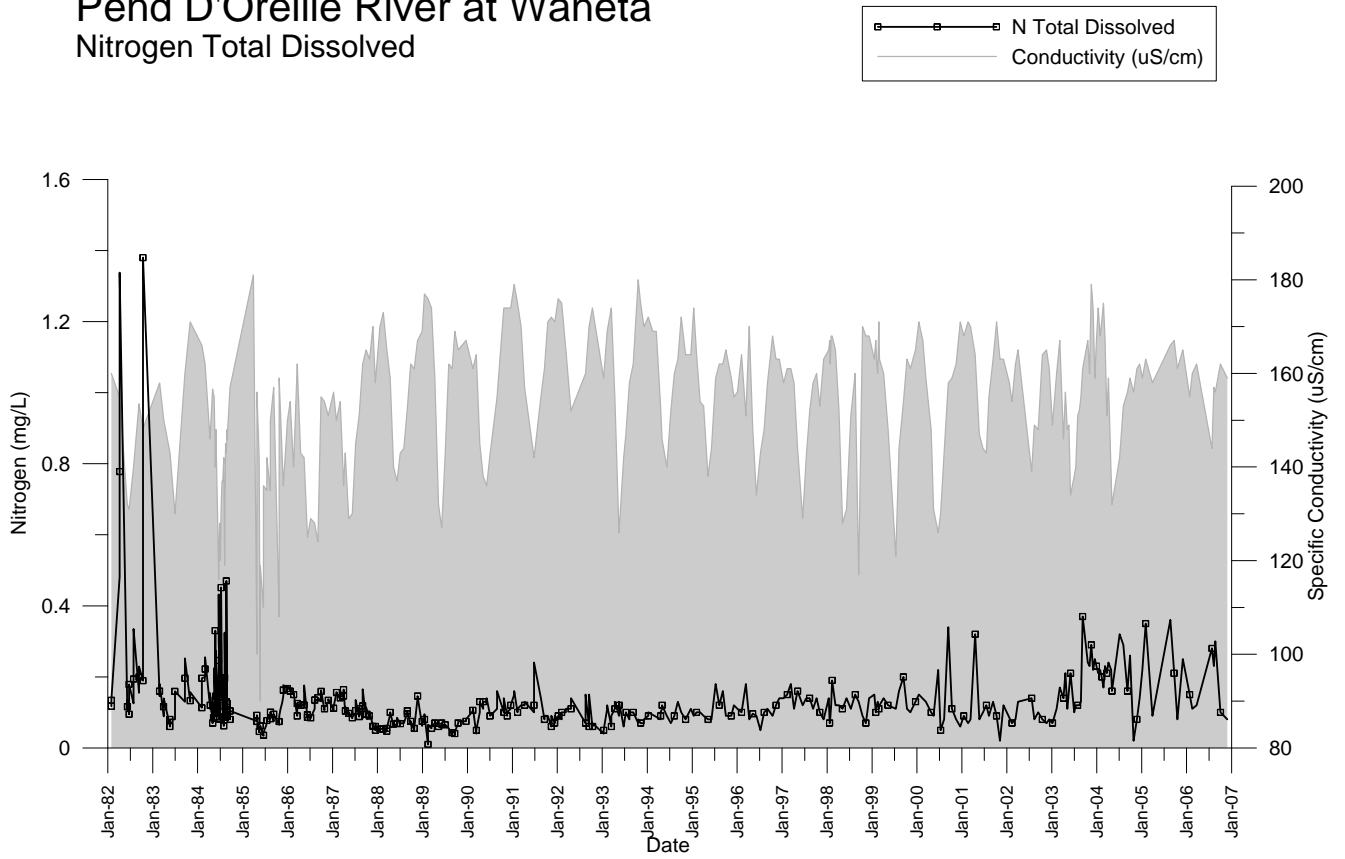


Figure 43
Pend D'Oreille River at Waneta
Sodium Dissolved and Extractable

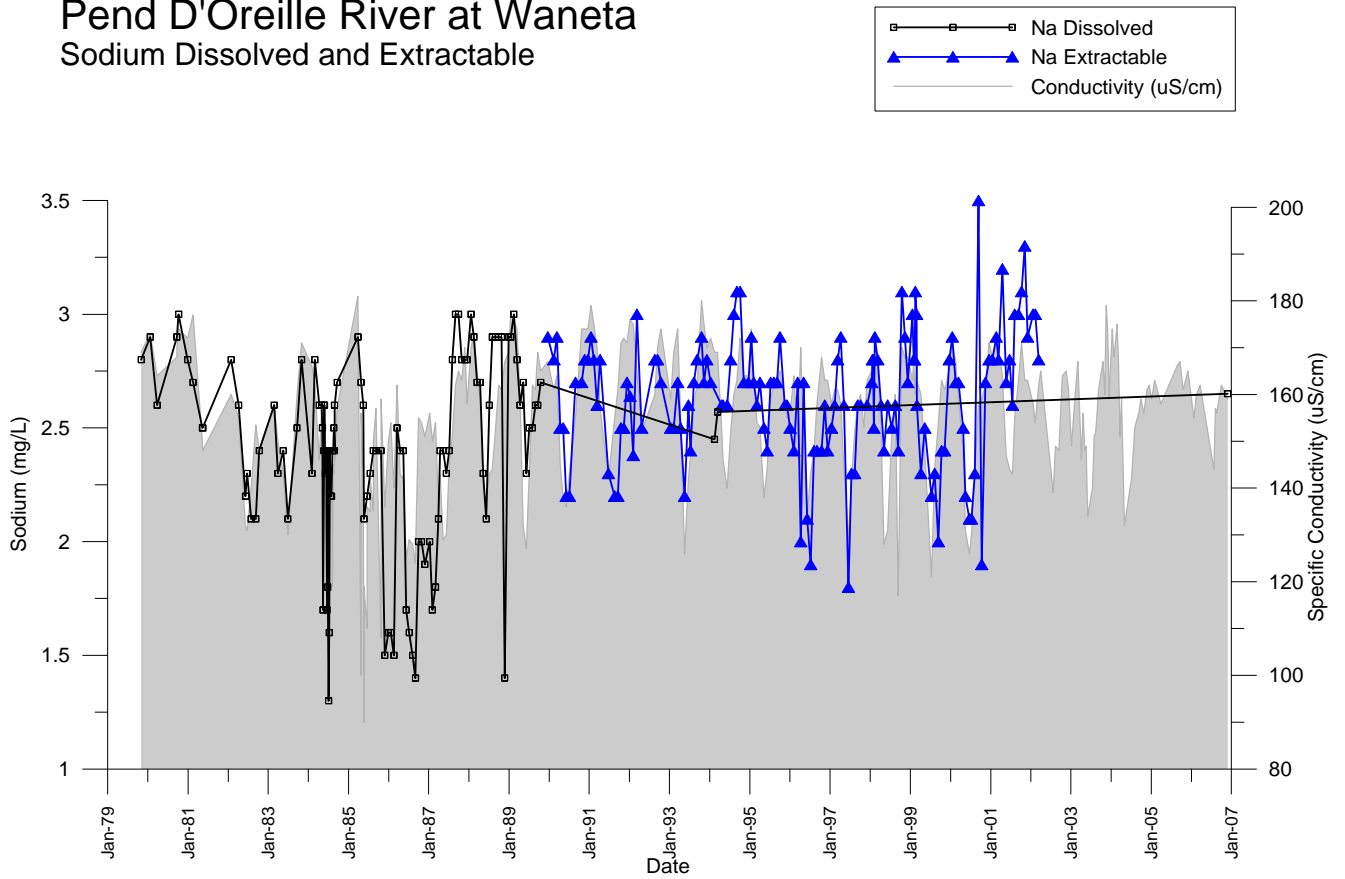


Figure 44
Pend D'Oreille River at Waneta
Niobium Extractable

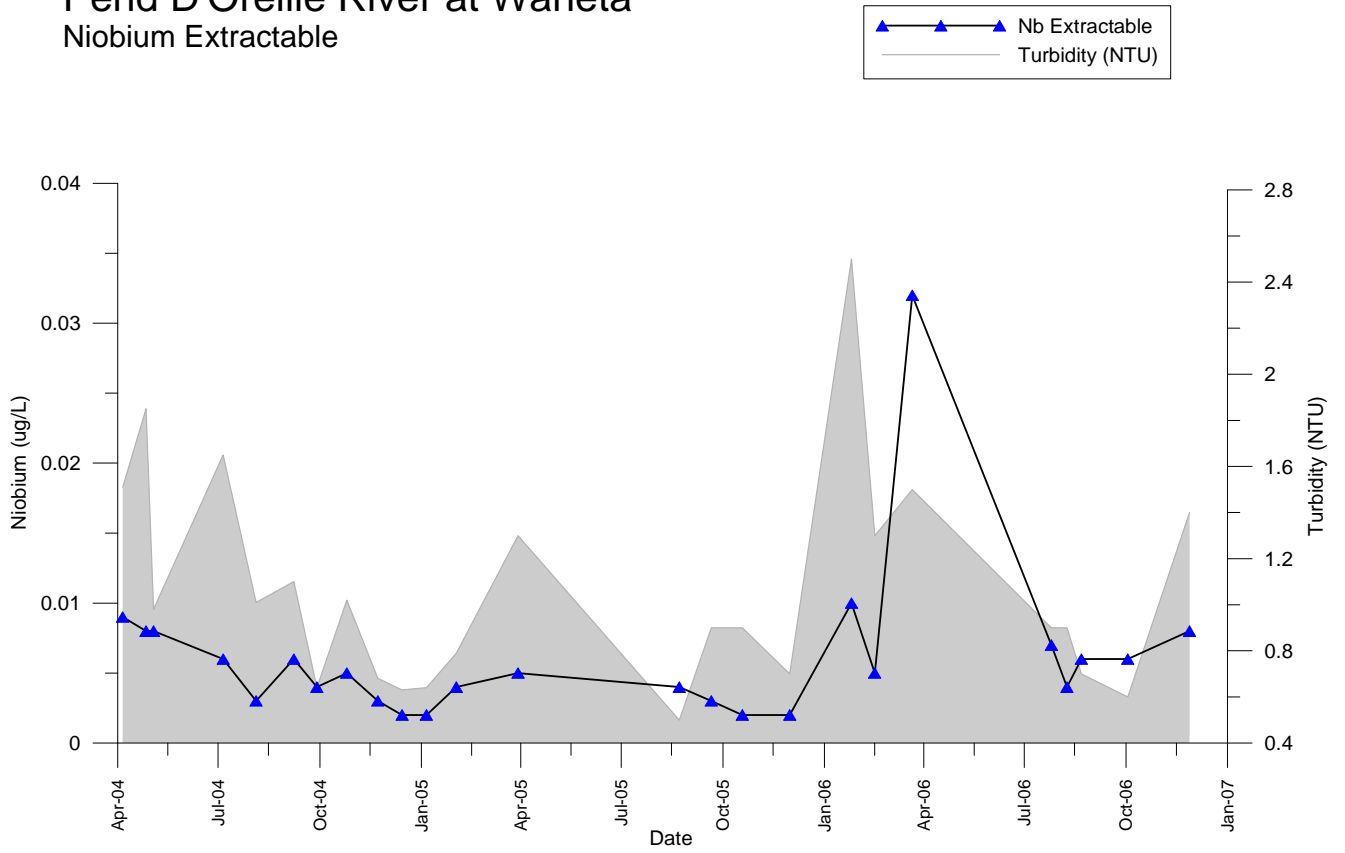


Figure 45
Pend D'Oreille River at Waneta
Nickel Total and Extractable

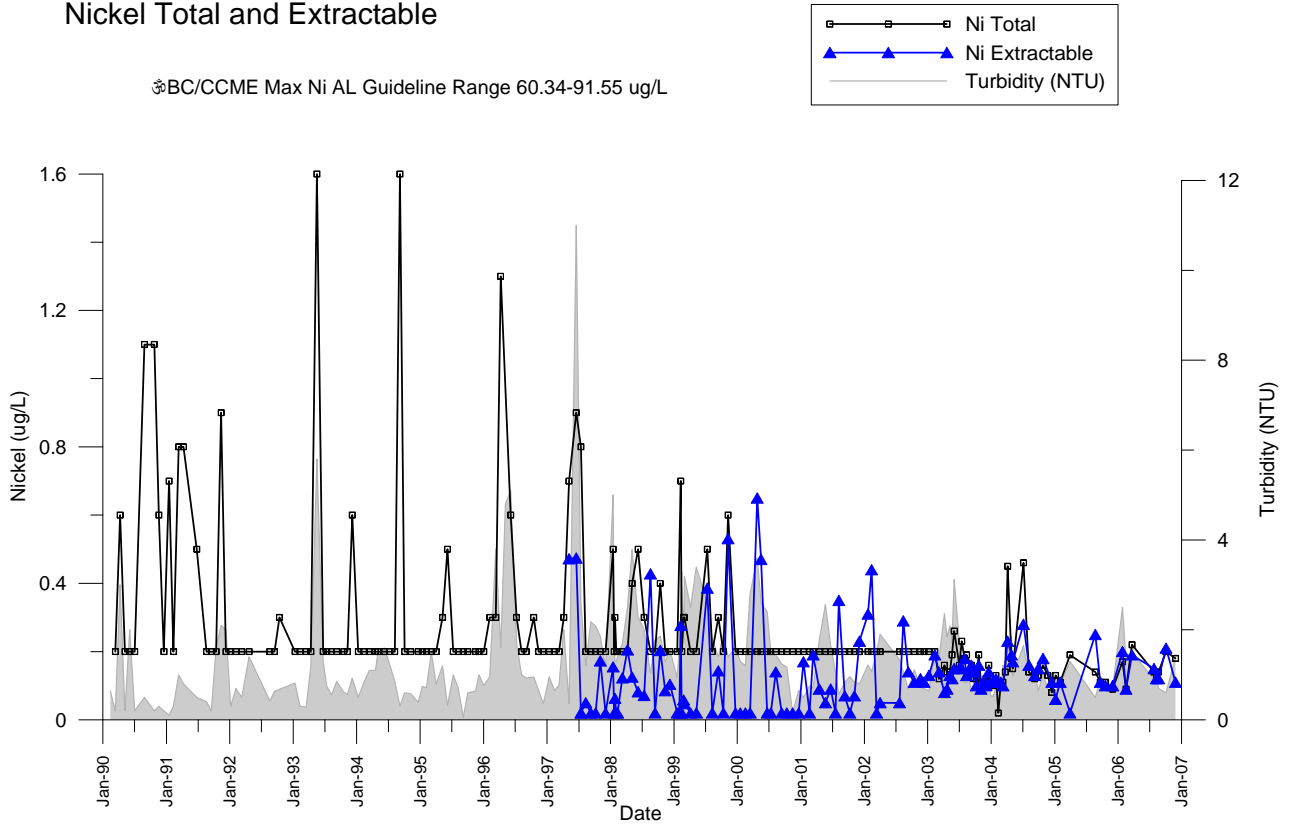


Figure 46
Pend D'Oreille River at Waneta
Phosphorous Total and Total Dissolved

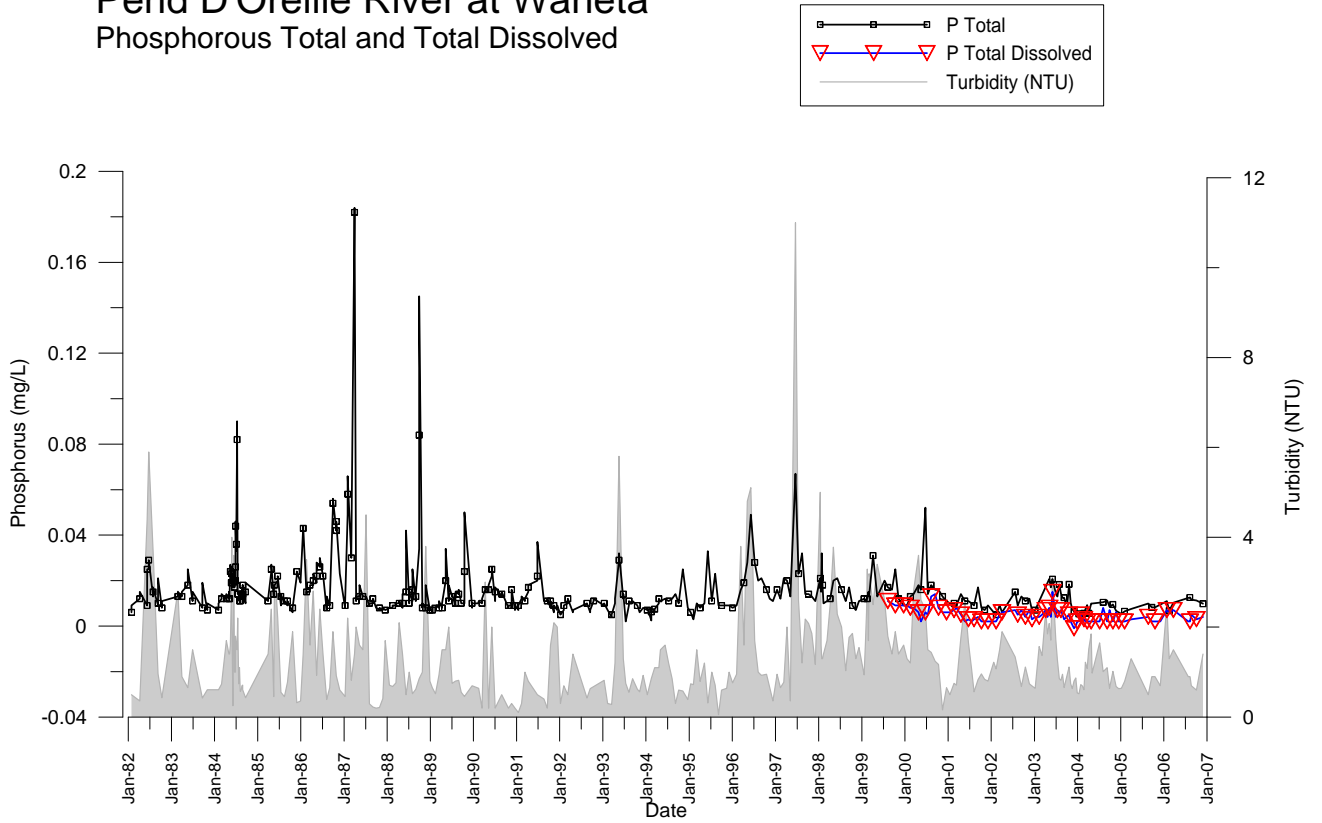


Figure 47
Pend D'Oreille River at Waneta
pH

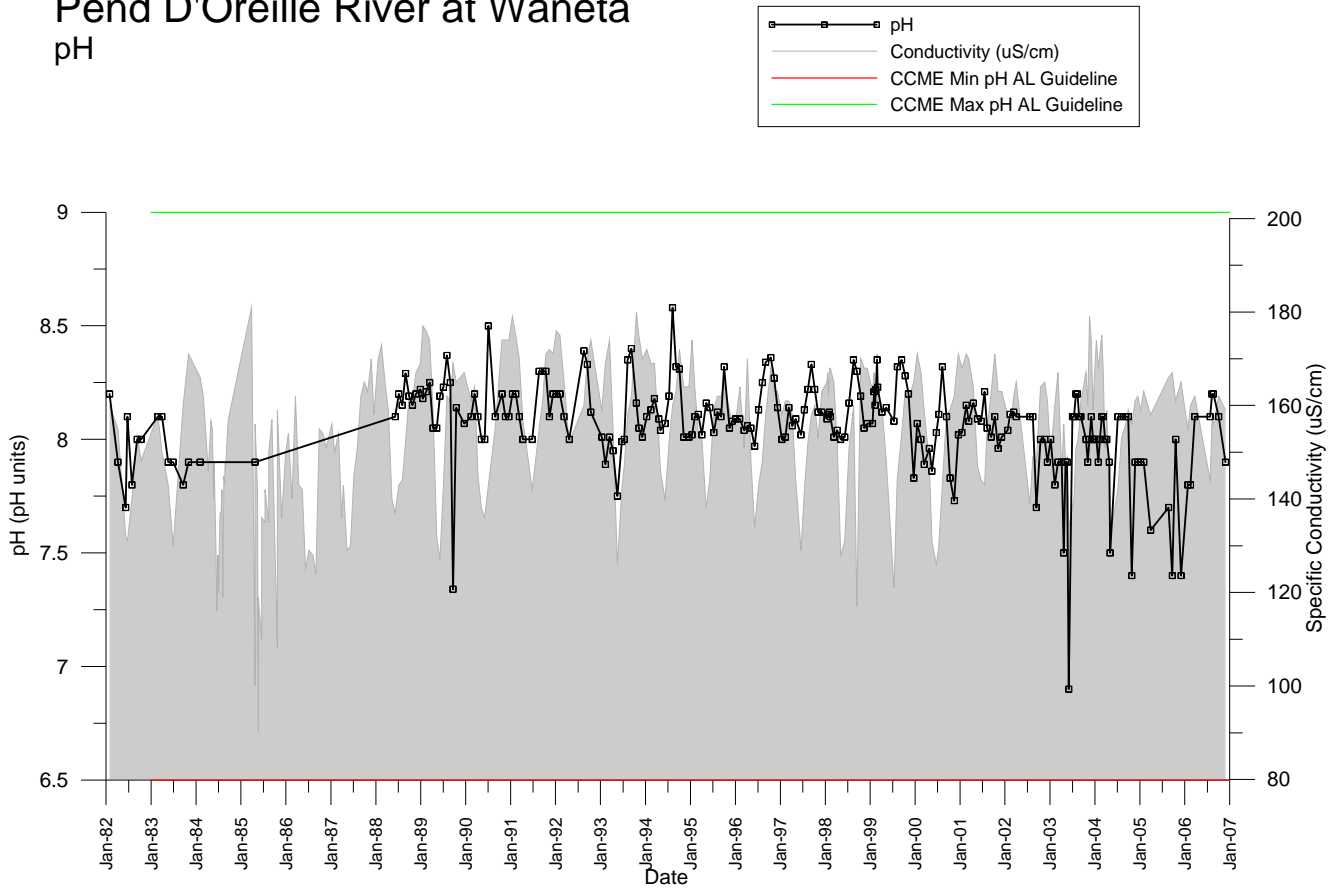


Figure 48
Pend D'Oreille River at Waneta
Rubidium versus Turbidity

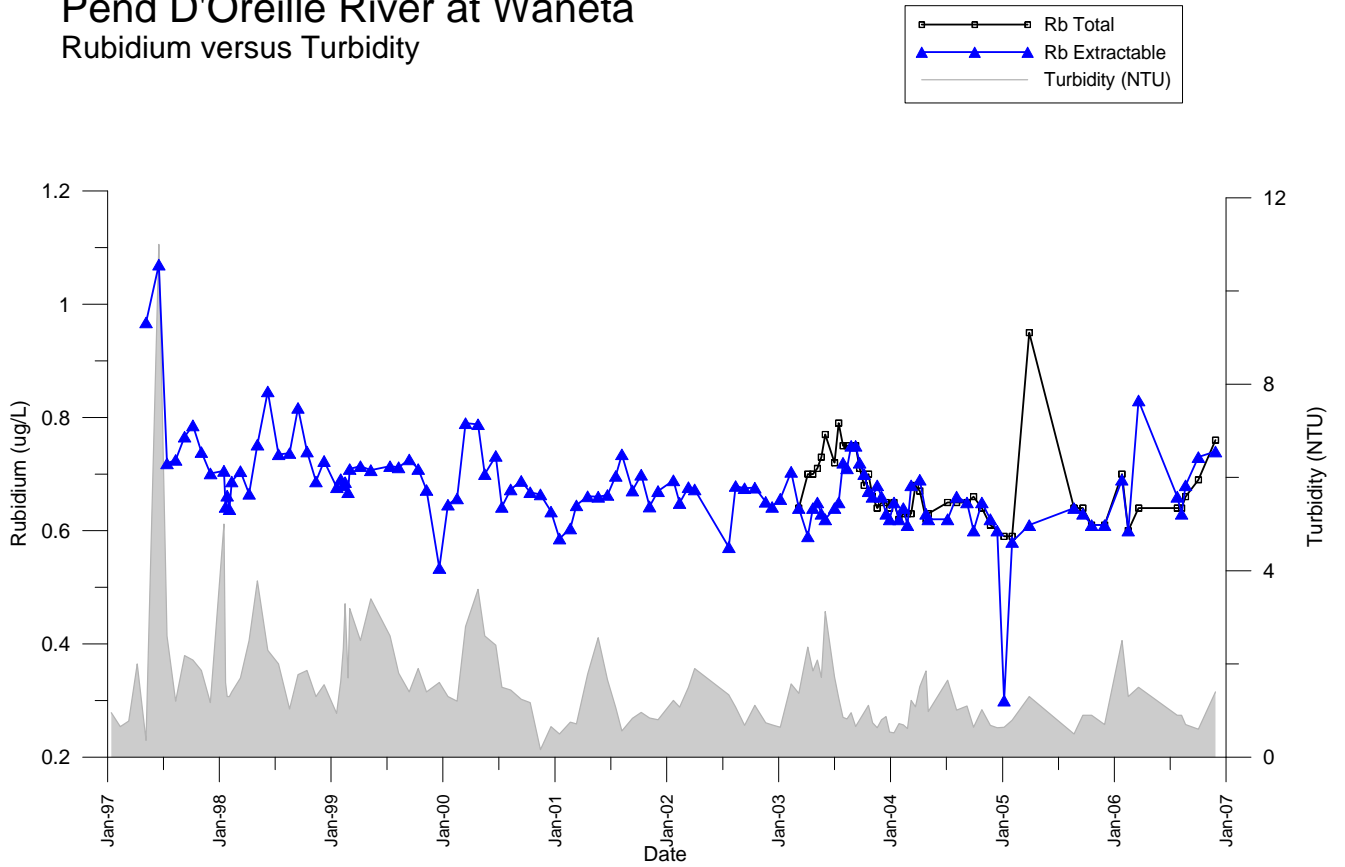


Figure 49
Pend D'Oreille River at Waneta
Rubidium versus Specific Conductivity

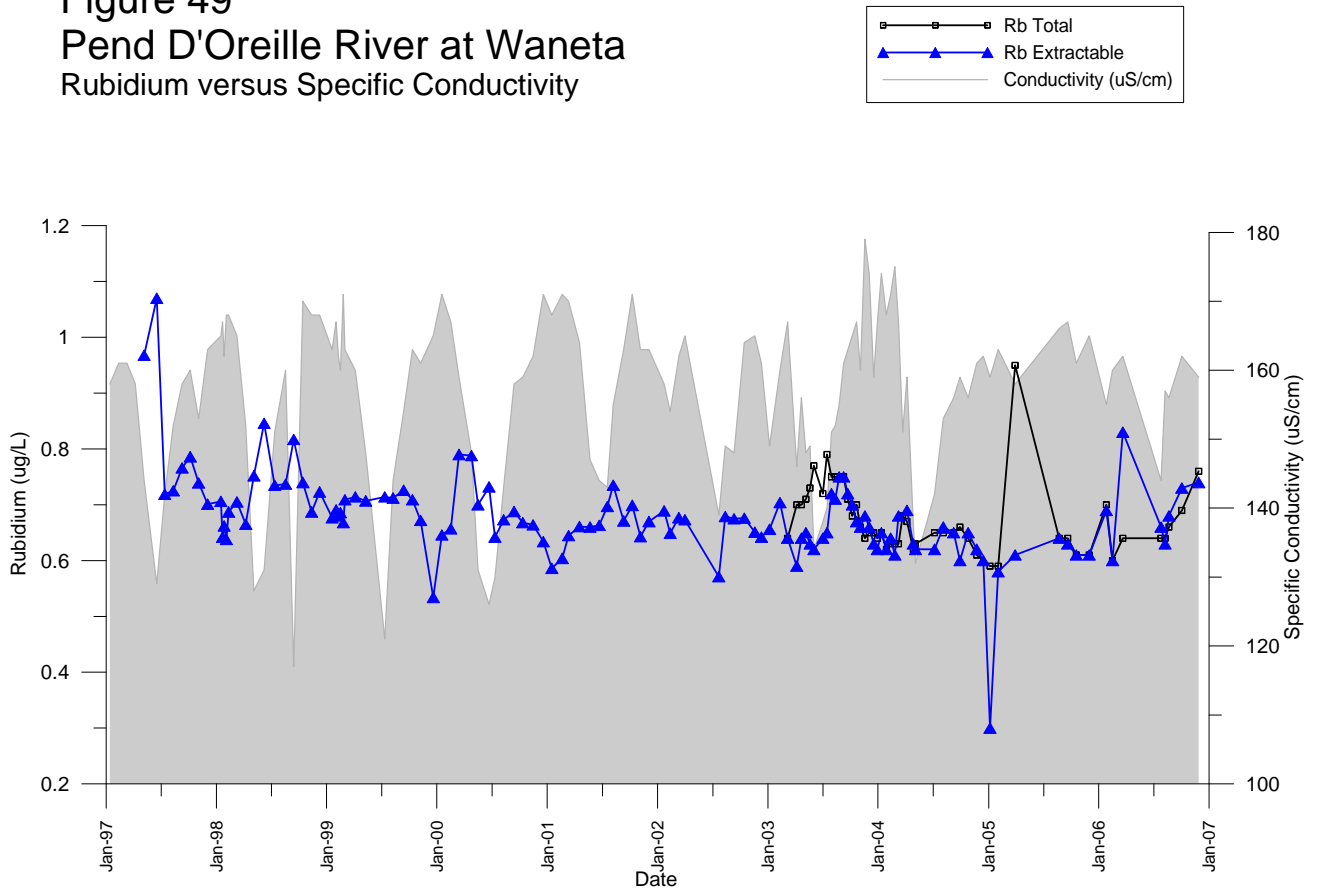


Figure 50
Pend D'Oreille River at Waneta
Residue Filterable

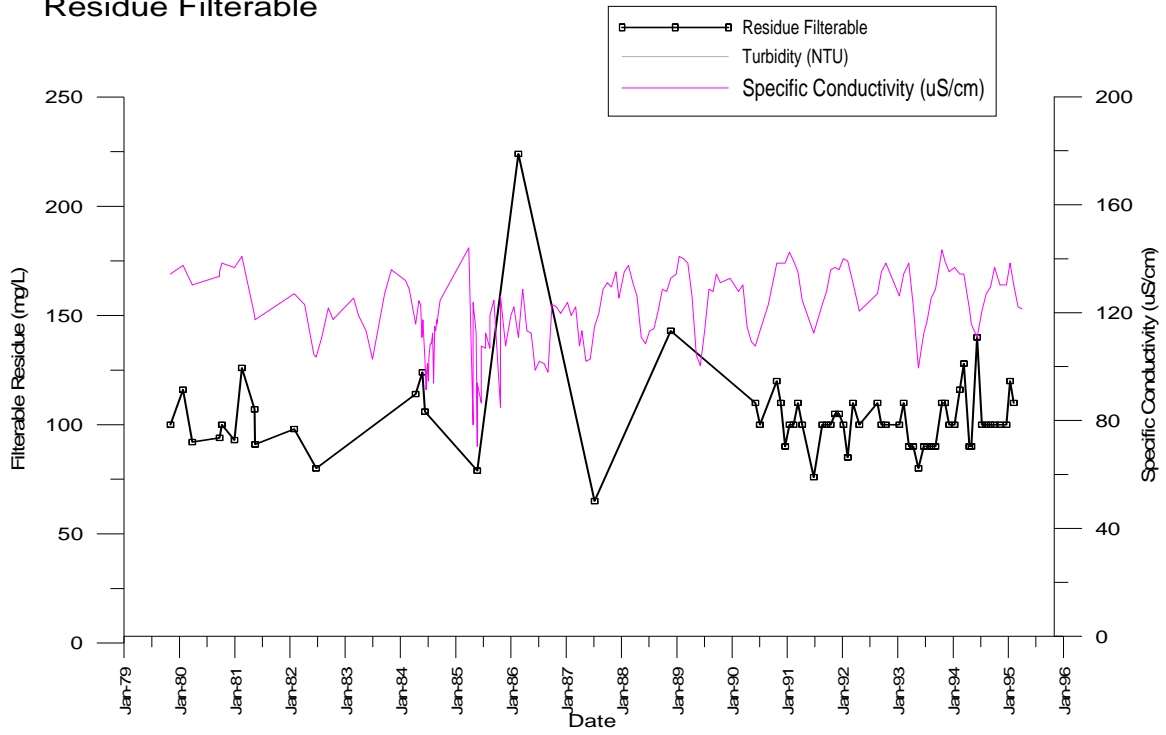


Figure 51
Pend D'Oreille River at Waneta
 Residue Fixed Filterable

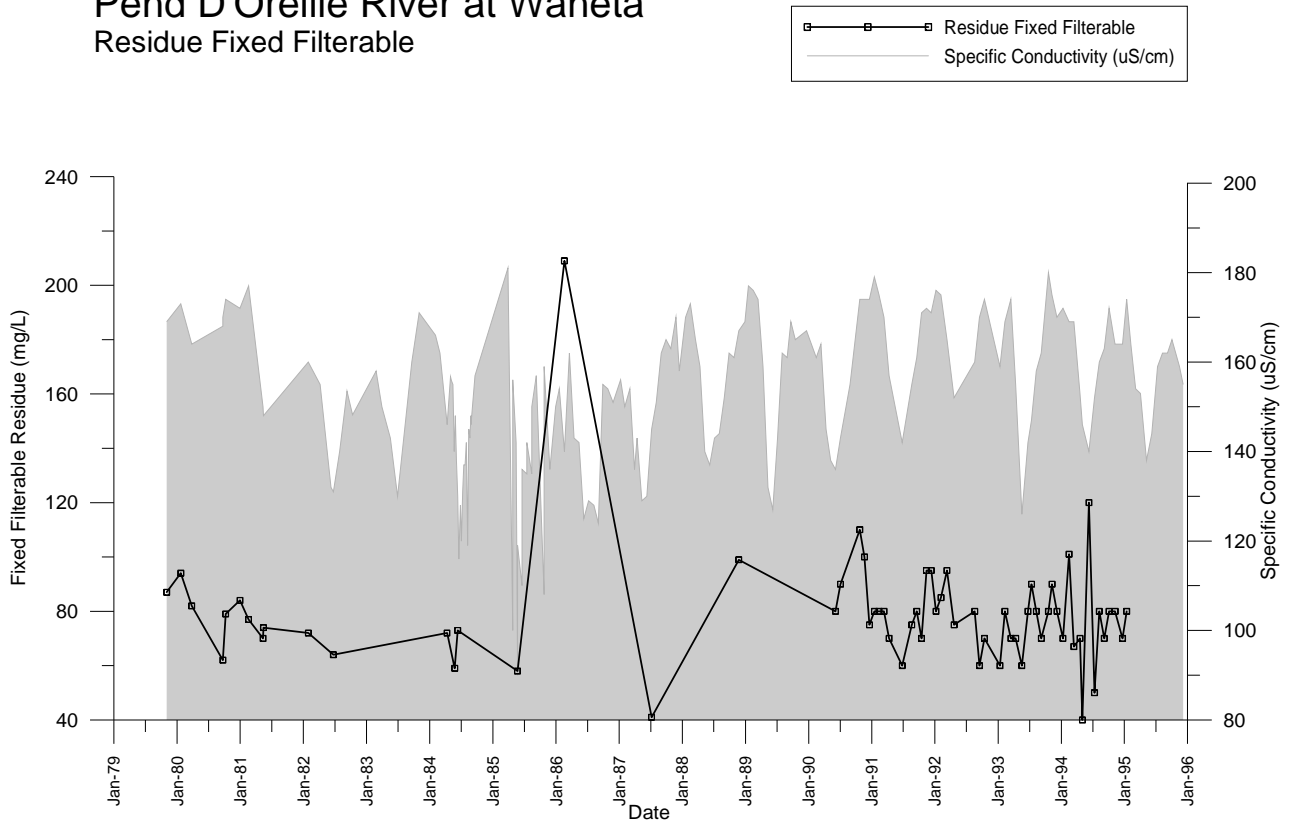


Figure 52
Pend D'Oreille River at Waneta
Residue Fixed Non-filterable

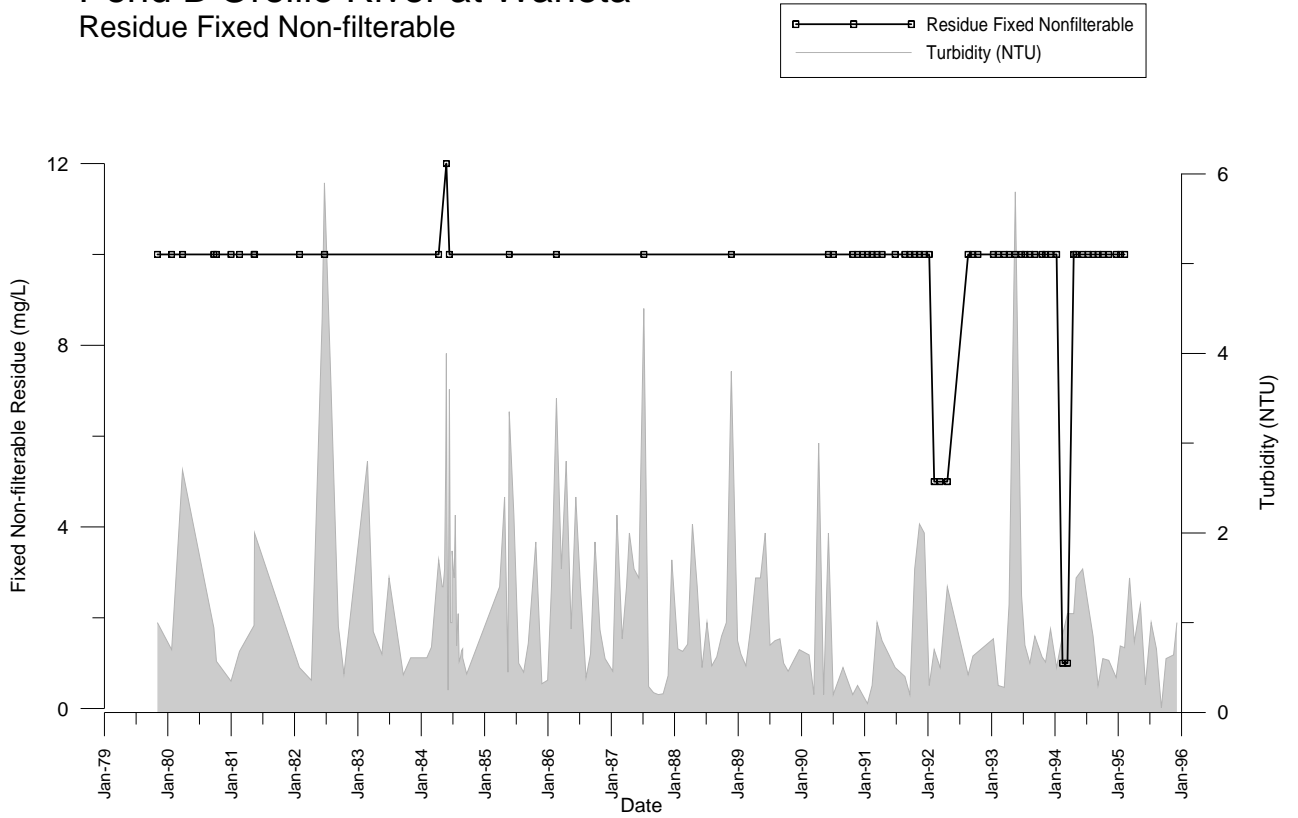


Figure 53
Pend D'Oreille River at Waneta
Residue Non-filterable

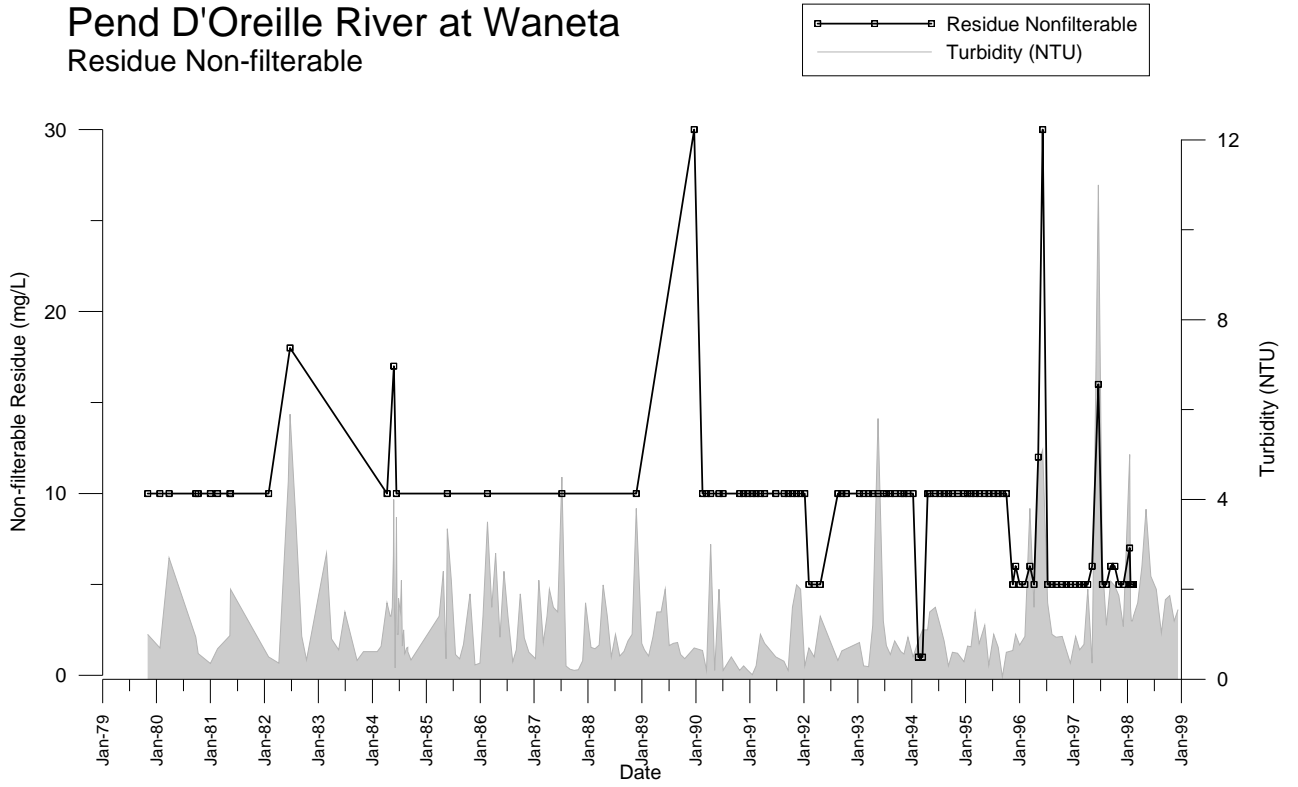


Figure 54
Pend D'Oreille River at Waneta
Selenium Total and Extractable

⊕BC/CCME DW Guideline Max-10 ug/L
 ⊕BC/30-Day AL Guideline Max-2 ug/L mean

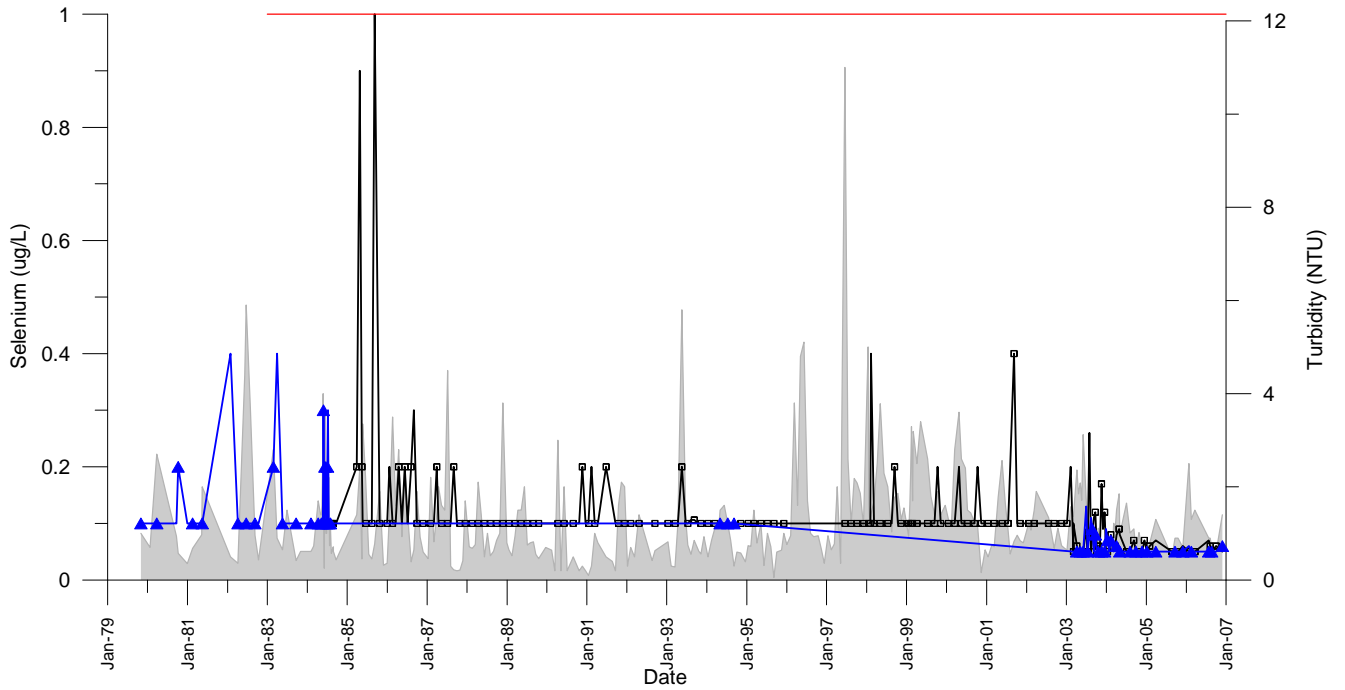
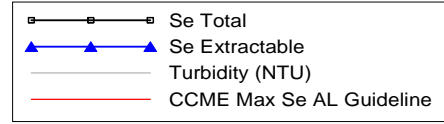


Figure 55
Pend D'Oreille River at Waneta
Silicon Extractable

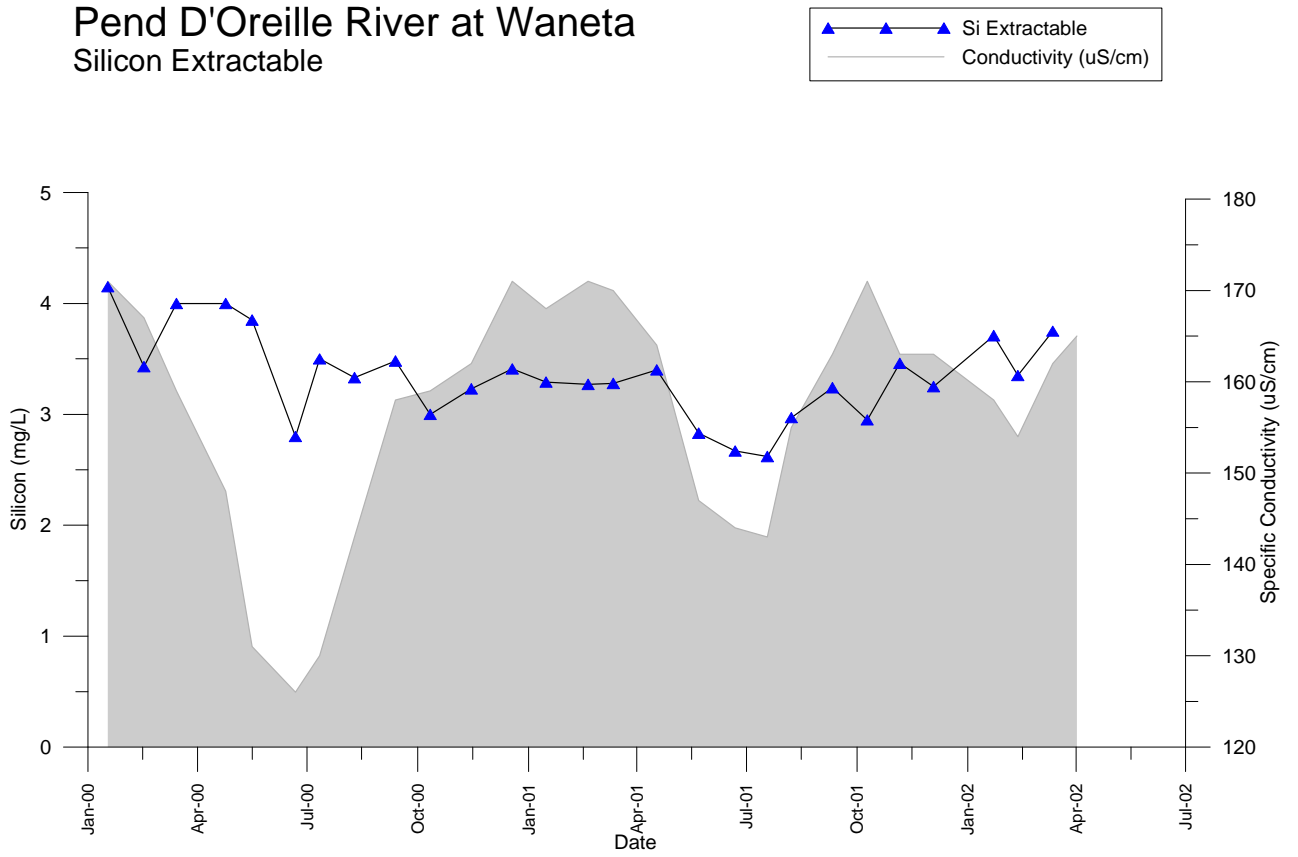


Figure 56
Pend D'Oreille River at Waneta
Silica Reactive and Dissolved

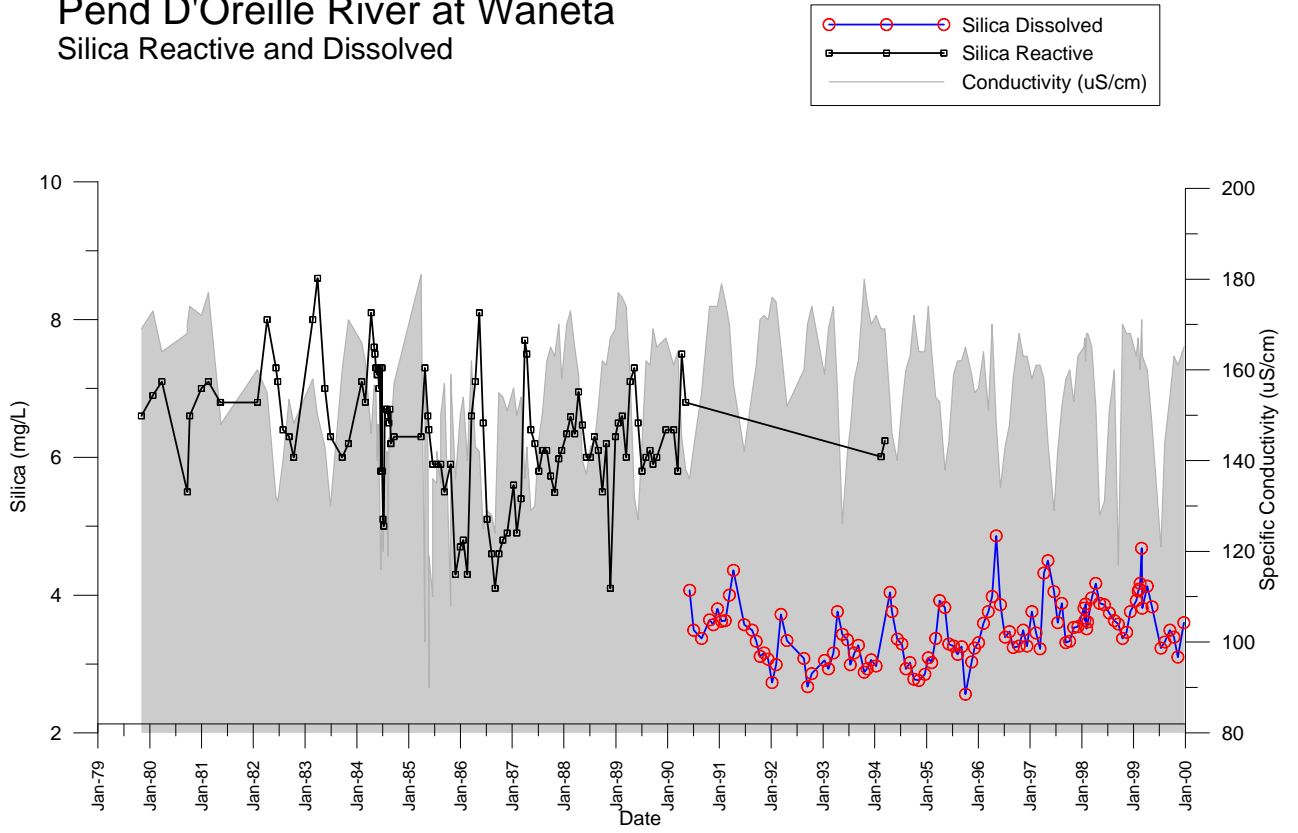


Figure 57
Pend D'Oreille River at Waneta
Silver (2003 - 2006)

⊗ BC Max Ag AL Guideline 0.1 ug/L
 ⊗ 30-Day-BC Ag AL Guideline 0.05 ug/L
 ⊗ CCME Max Ag AL Guideline 0.1 ug/L

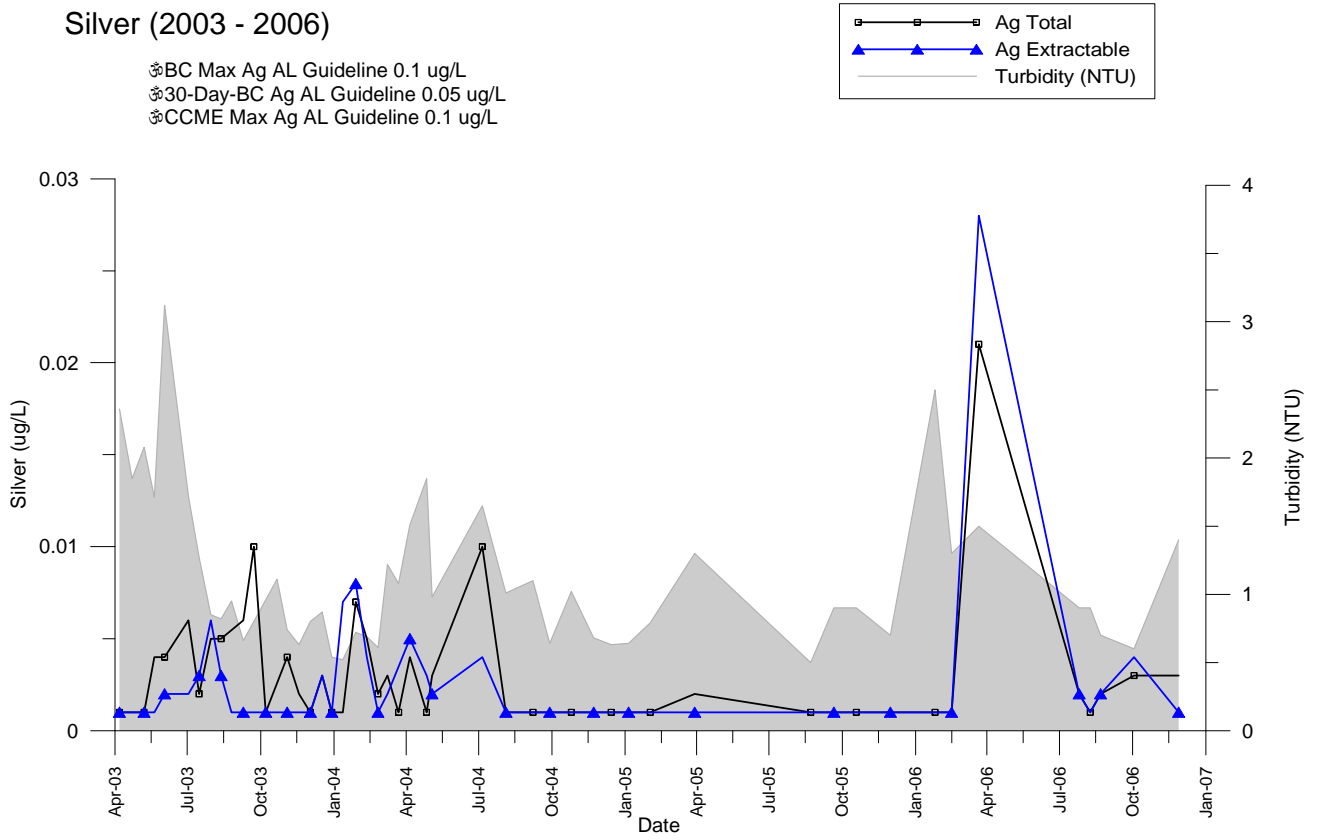


Figure 58
Pend D'Oreille River at Waneta
Silver (1996 - 2006)

⊗ BC Max Ag AL Guideline 0.1 ug/L
 ⊗ 30-Day-BC Ag AL Guideline 0.05 ug/L
 ⊗ CCME Max Ag AL Guideline 0.1 ug/L

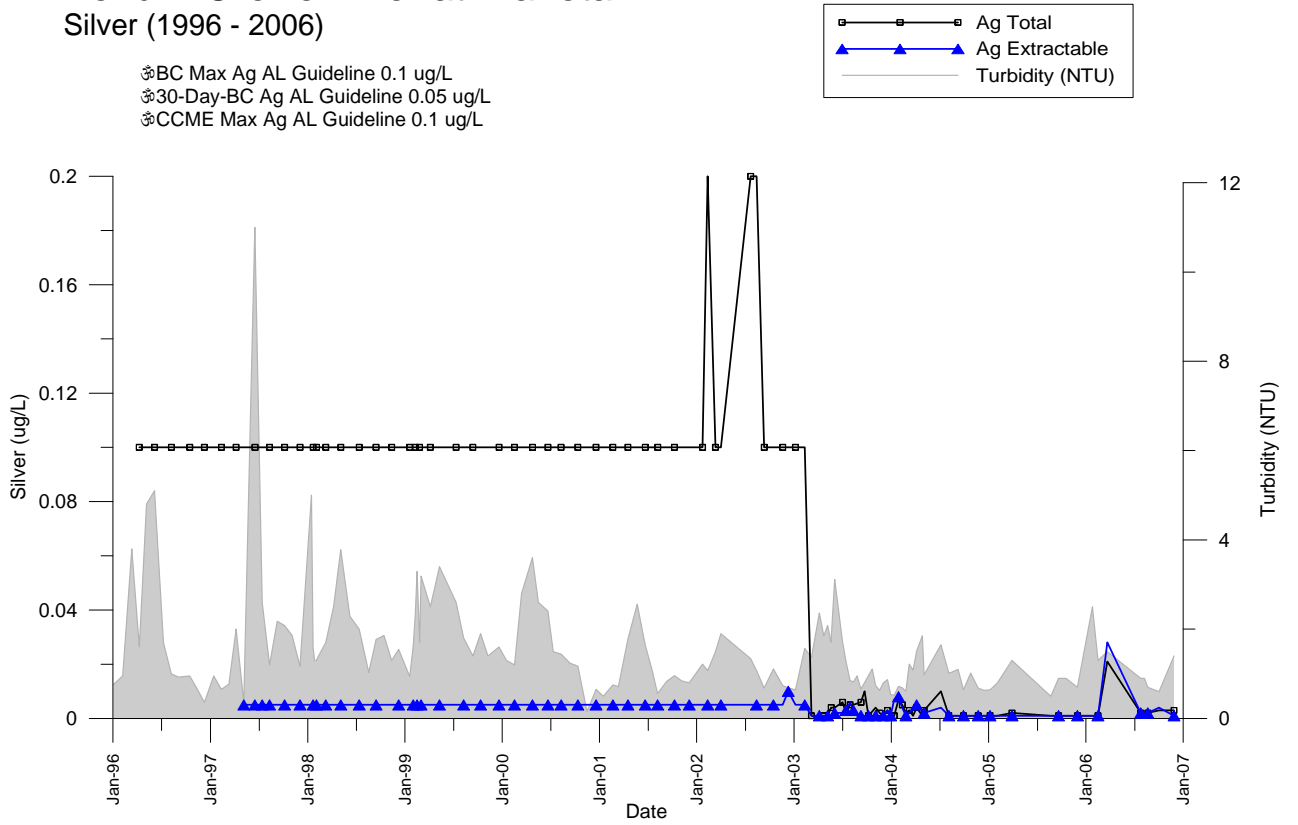


Figure 59
Pend D'Oreille River at Waneta
Specific Conductivity

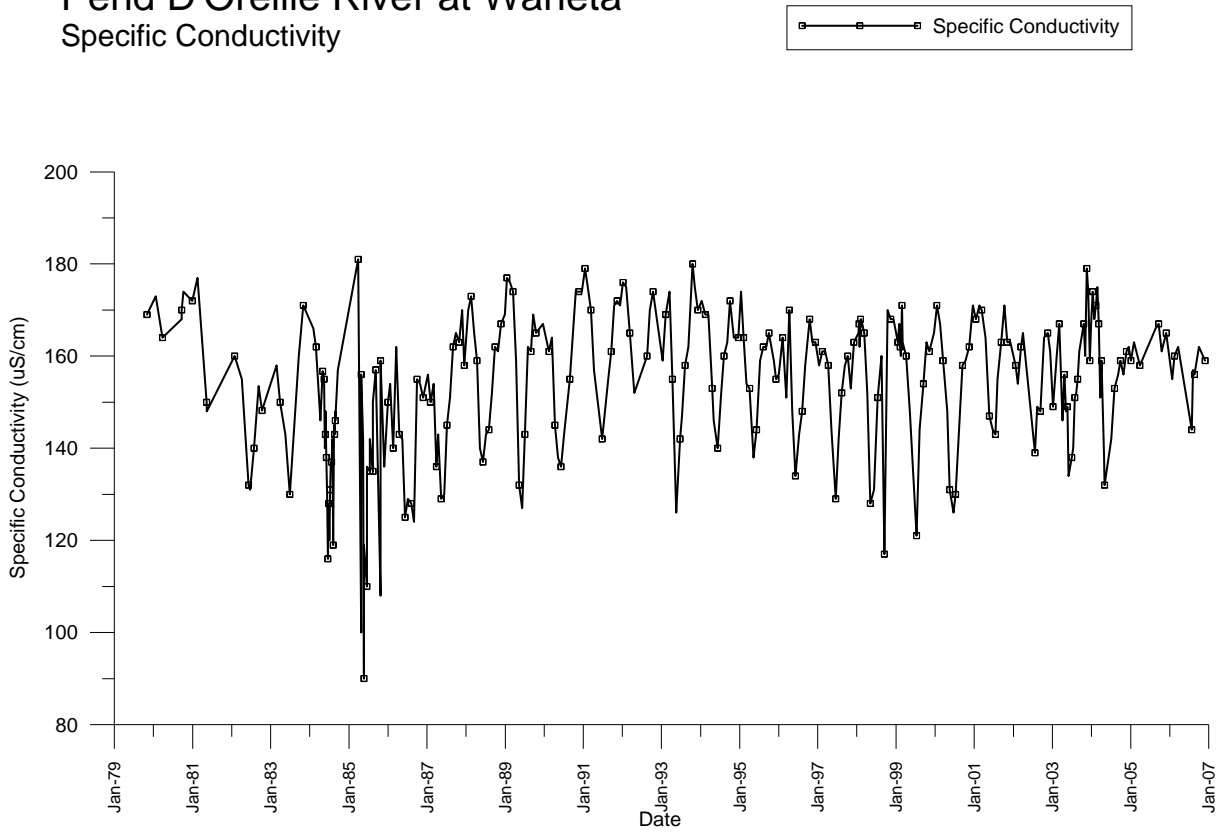


Figure 60
Pend D'Oreille River at Waneta
Strontium Total and Extractable

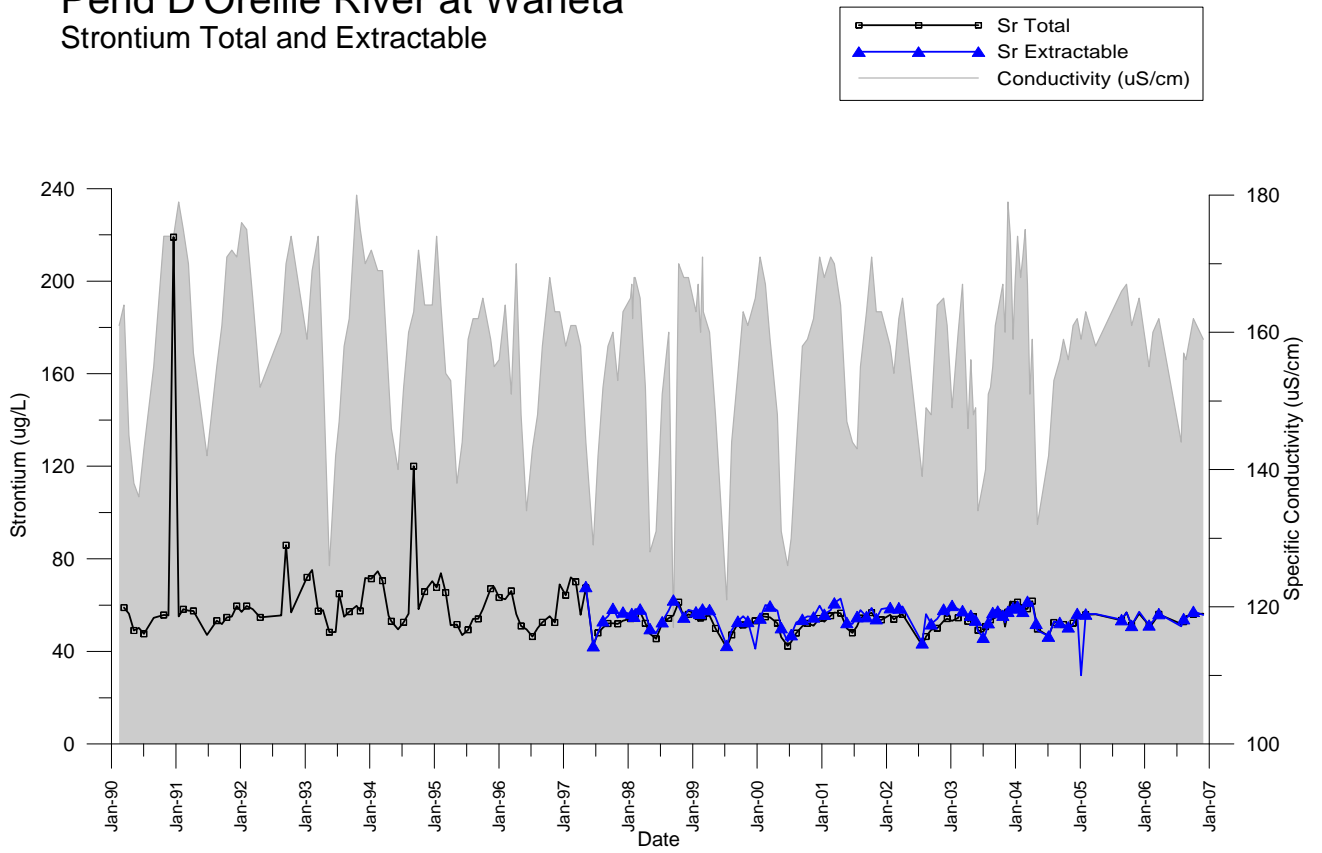


Figure 61
Pend D'Oreille River at Waneta
Sulphate Dissolved

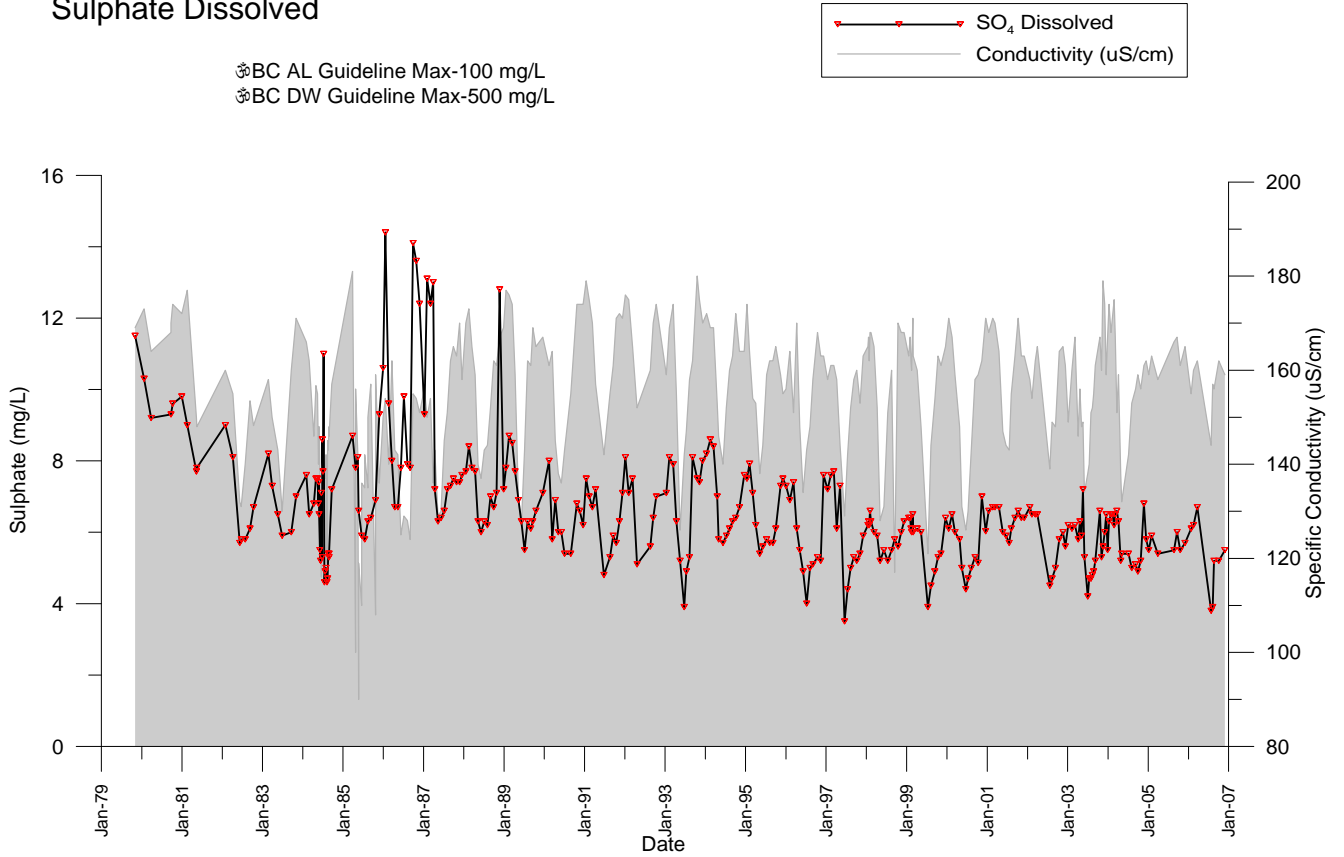


Figure 62
 Pend D'Oreille River at Waneta
 Temperature Air and Water

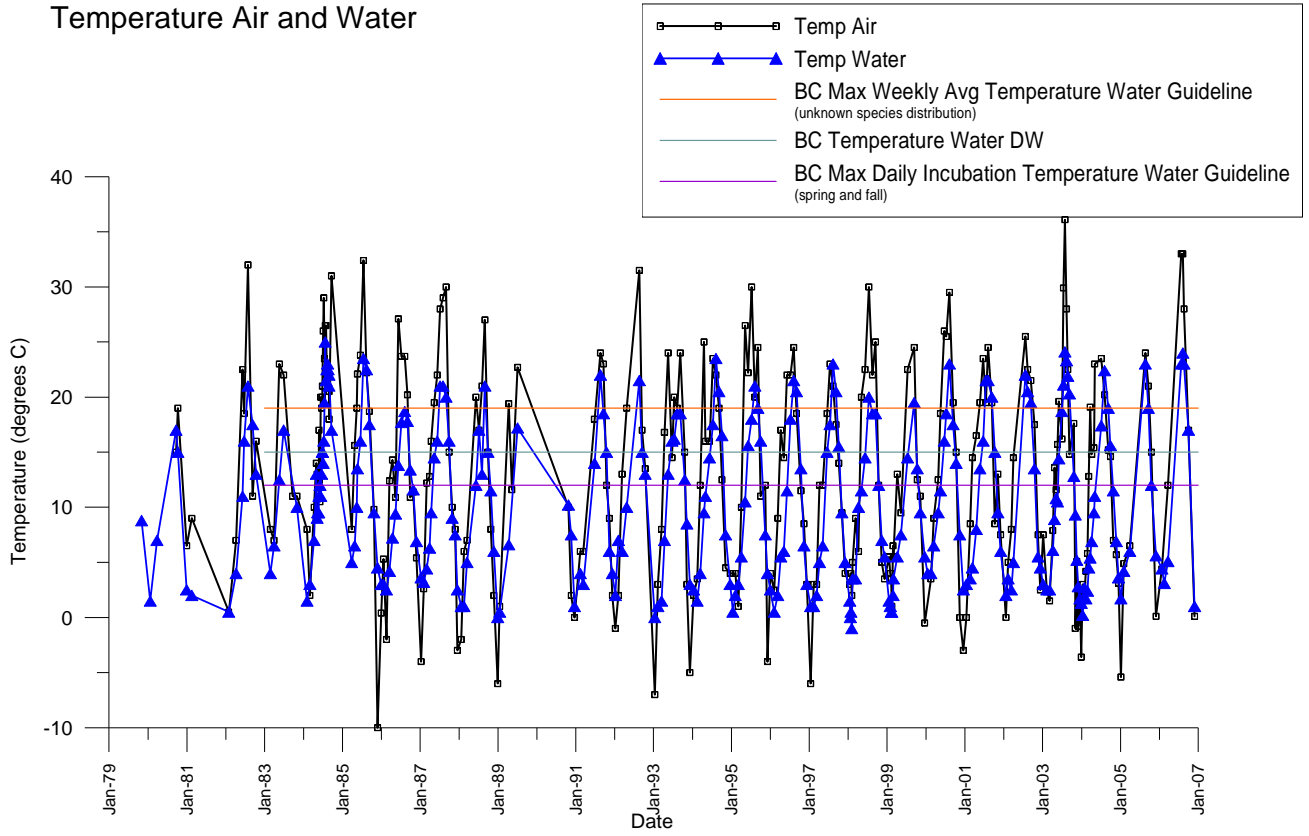


Figure 63
Pend D'Oreille River at Waneta
Tin Total and Extractable

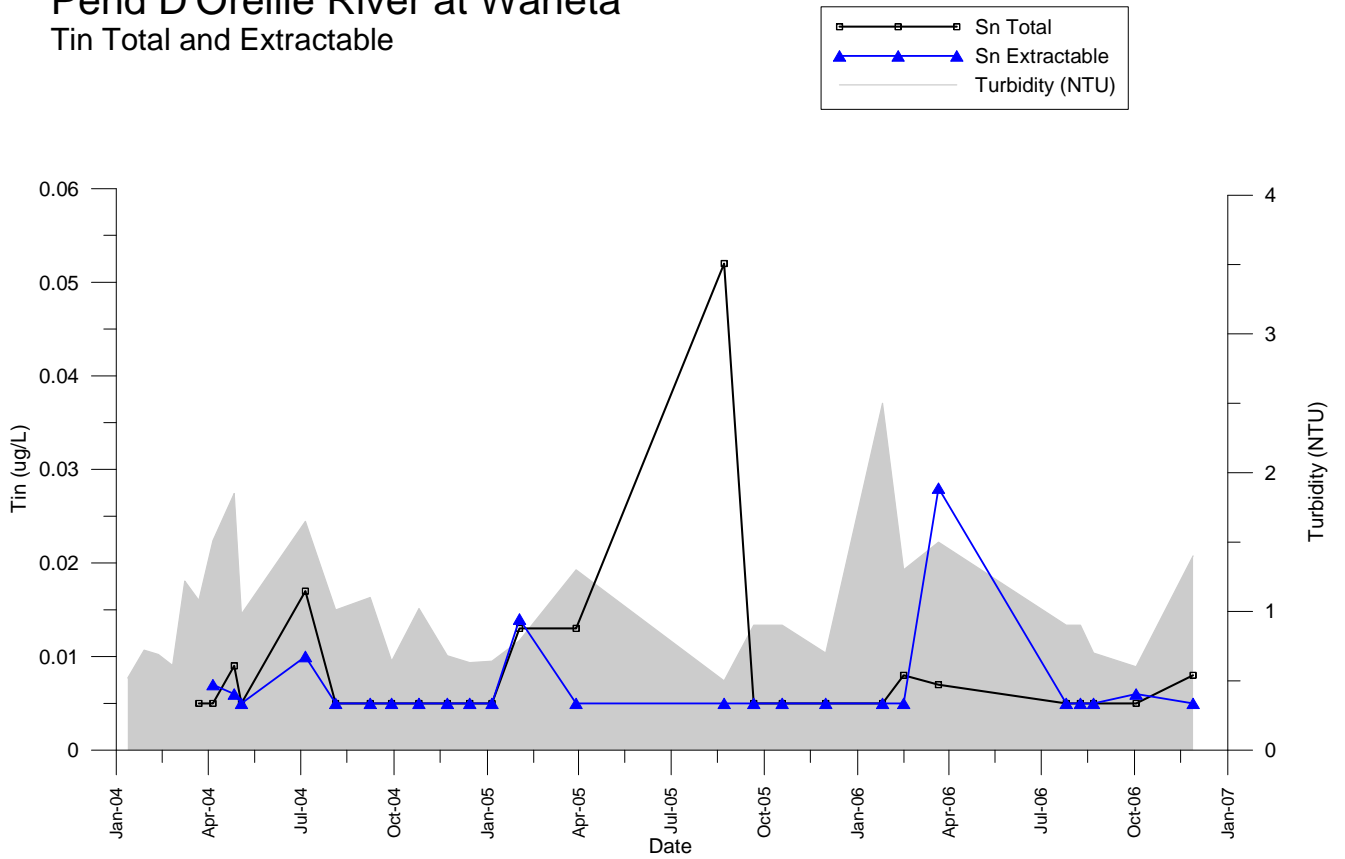


Figure 64
Pend D'Oreille River at Waneta
Thallium (1997 - 2006)

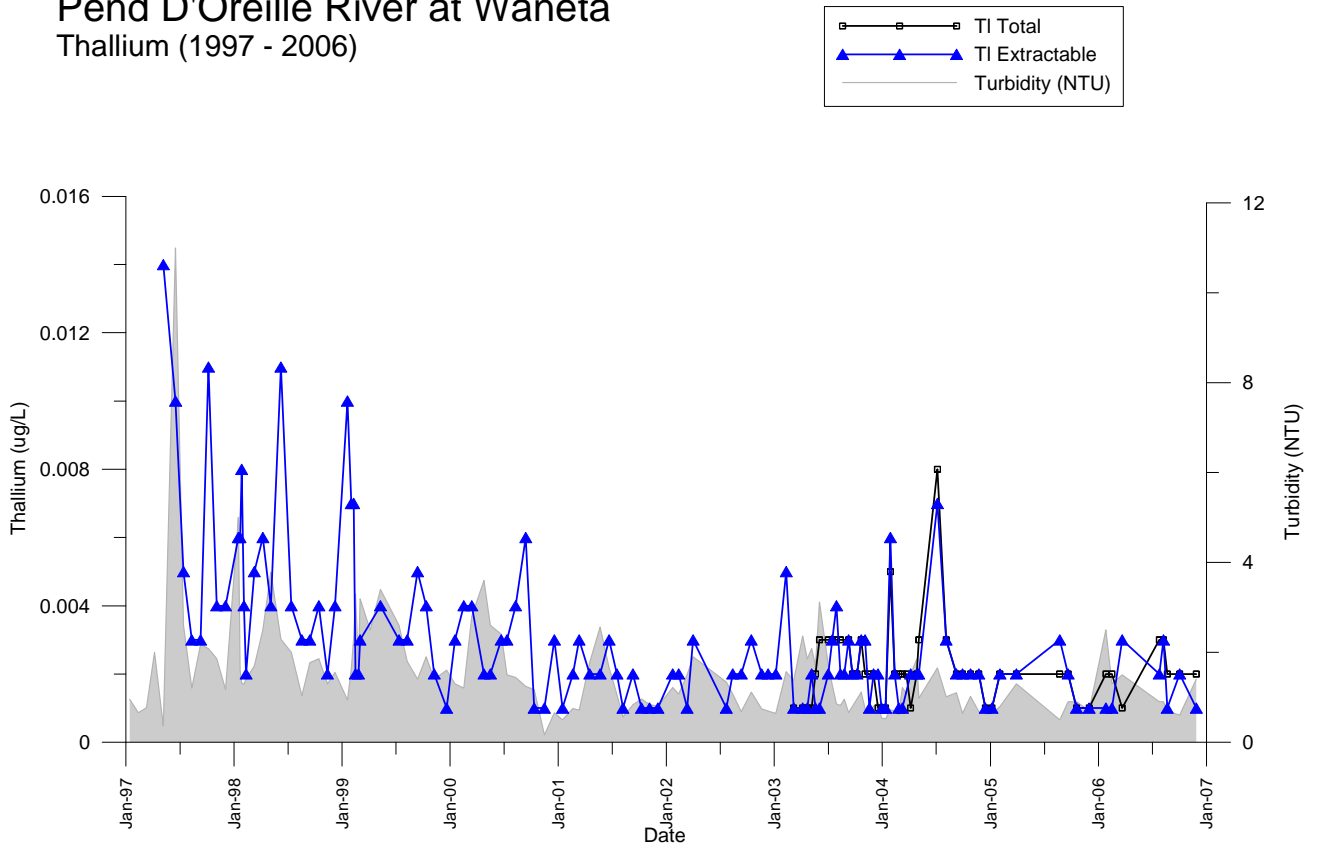


Figure 65
Pend D'Oreille River at Waneta
Thallium (1994 - 2006)

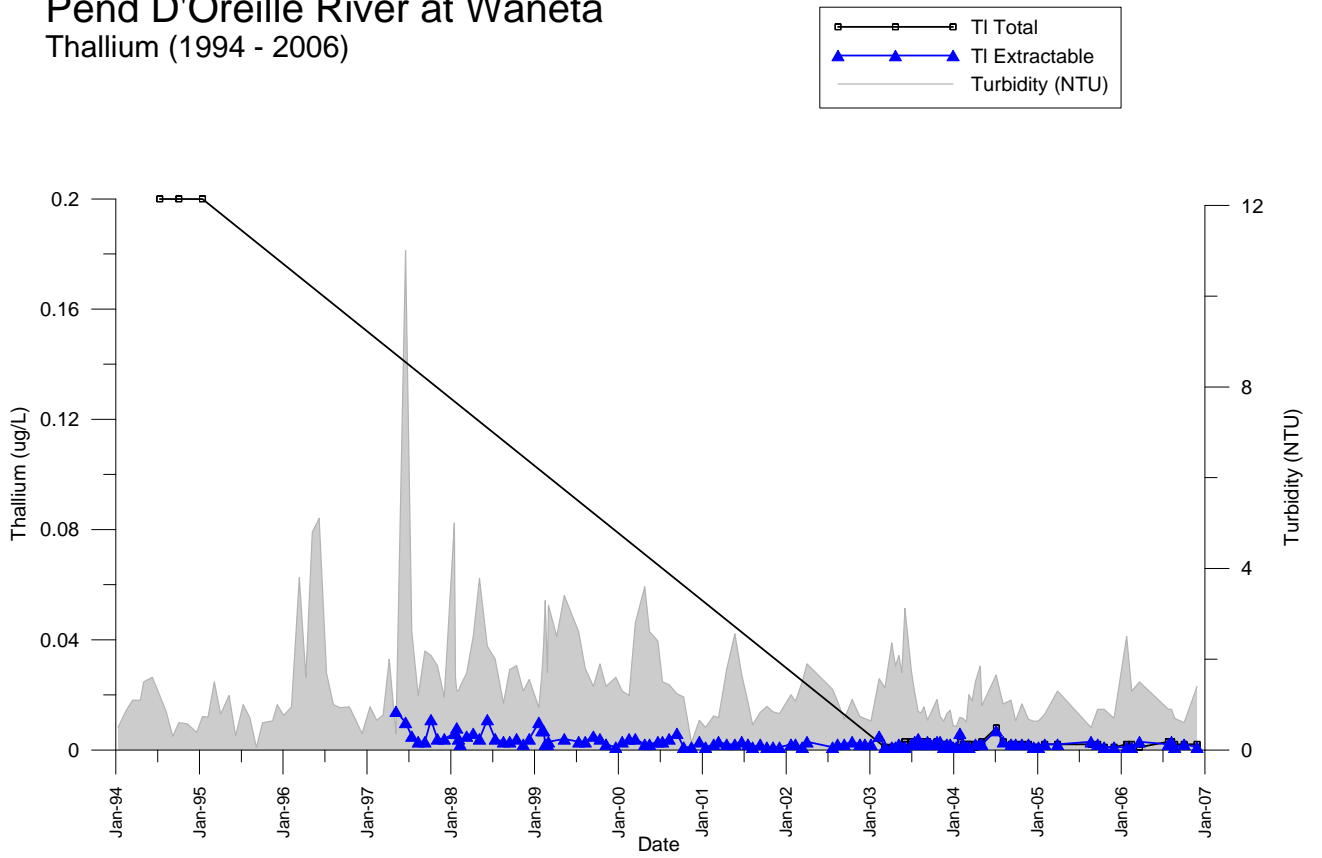


Figure 66
Pend D'Oreille River at Waneta
Turbidity

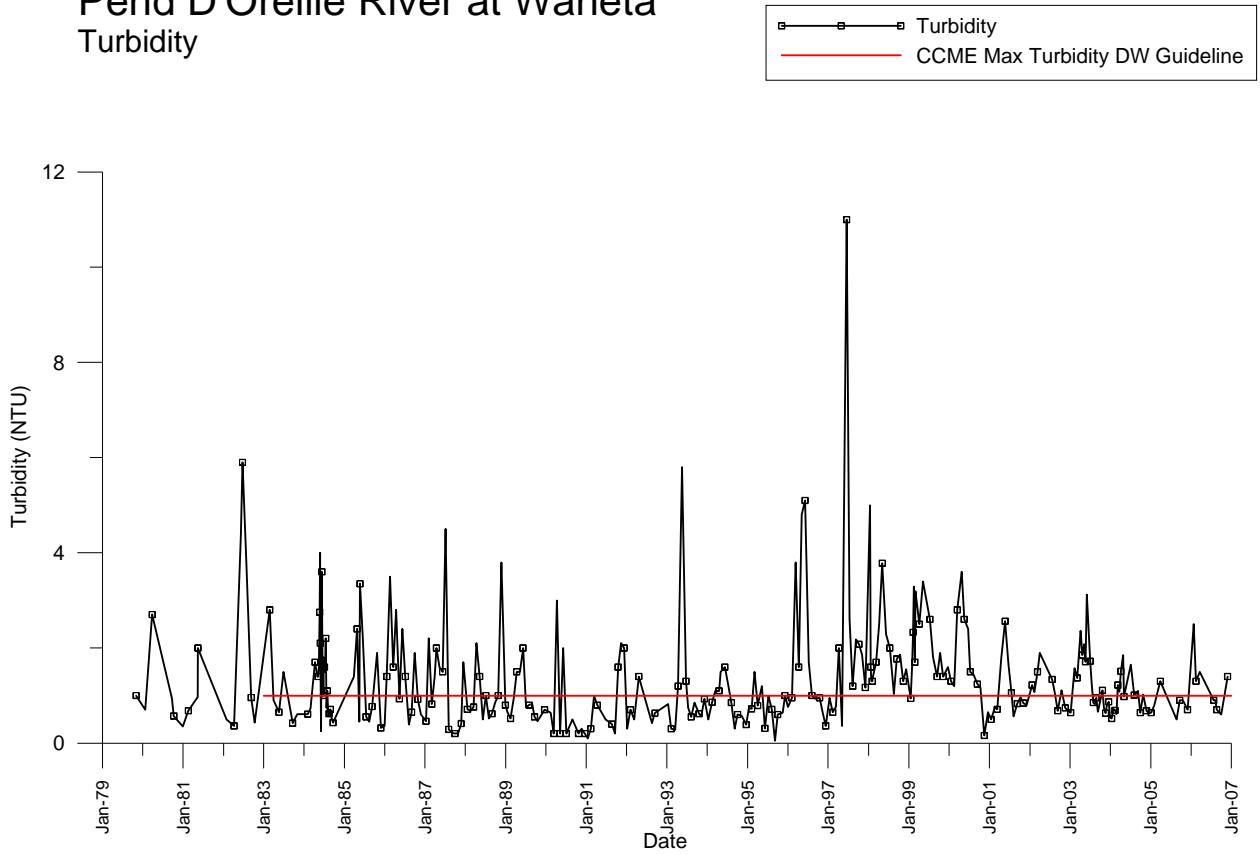


Figure 67
Pend D'Oreille River at Waneta
Uranium Total and Extractable

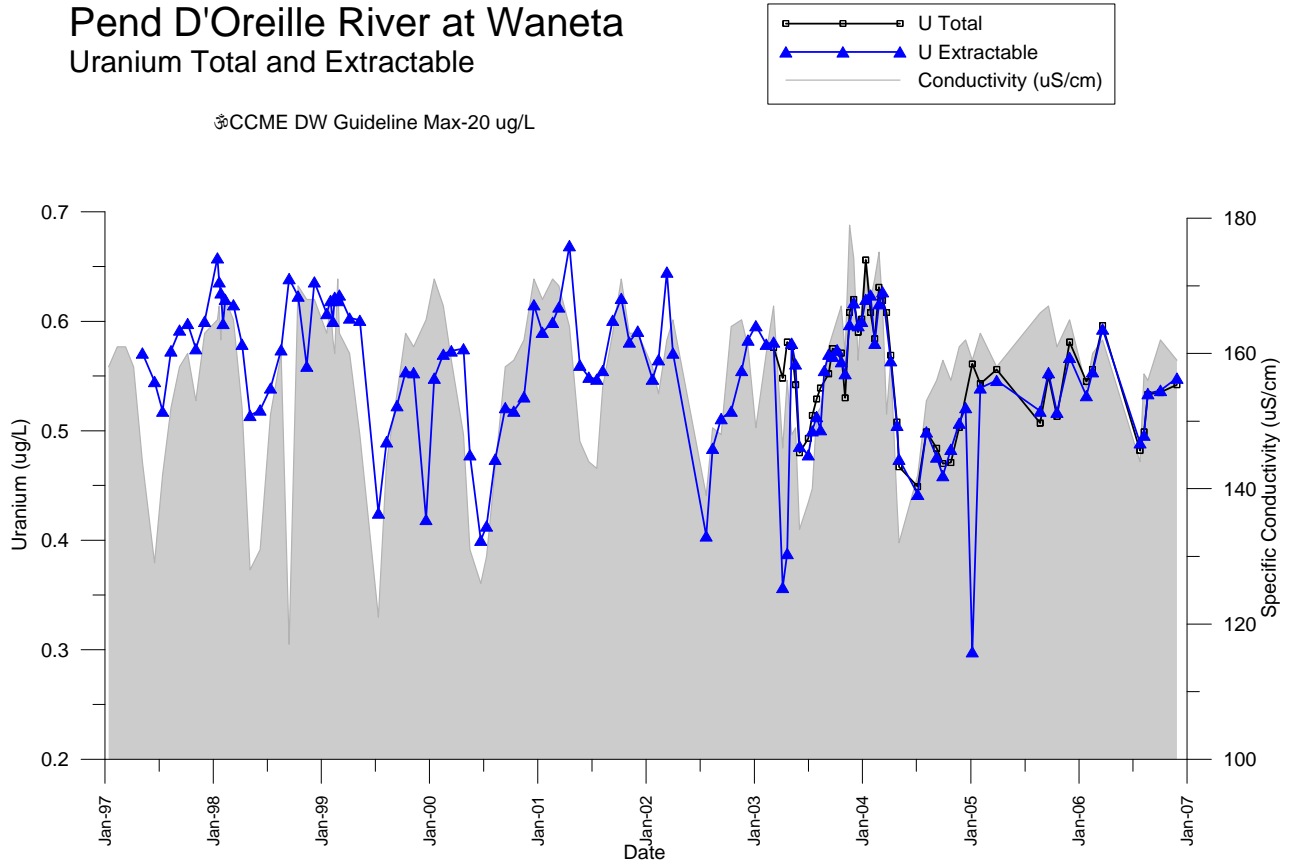


Figure 68
Pend D'Oreille River at Waneta
Vanadium Total and Extractable

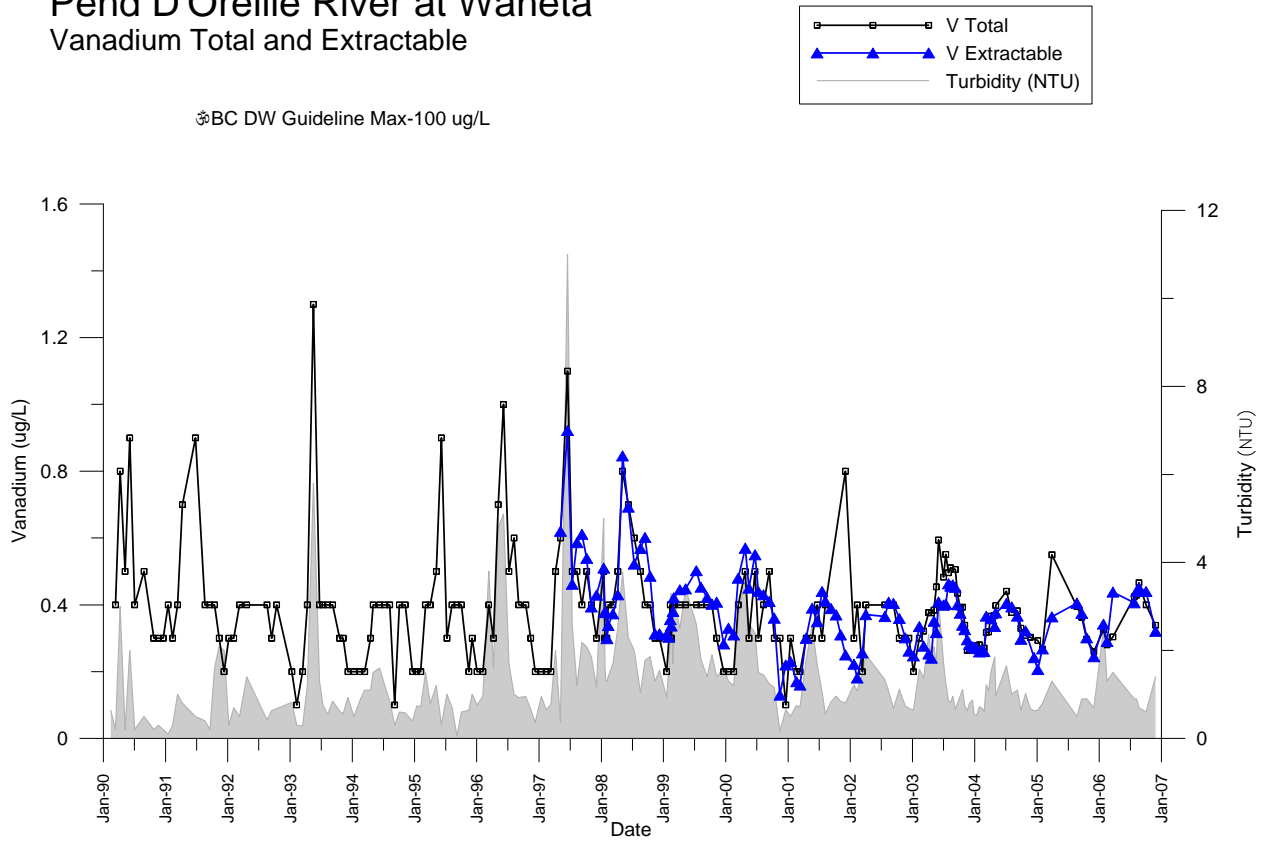


Figure 69
Pend D'Oreille River at Waneta
Zinc Total and Extractable

