CANADA – BRITISH COLUMBIA
WATER QUALITY MONITORING AGREEMENT

WATER QUALITY ASSESSMENT OF Similkameen River AT U.S. BORDER (1976 – 2006)

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Prepared for:
Ministry of Environment
and
Environment Canada

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Environment Canada Environnement Canada

BRITISH COLUMBIA
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Ministry of Environment

EXECUTIVE SUMMARY

The Similkameen River flows north-easterly through Manning Park to Princeton, and then south-easterly until it crosses the border with the United States just south from Cawston. The river enters the Okanagan River downstream from Osoyoos Lake in Washington State. There are four major population centres (Princeton, Hedley, Keremeos and Cawston) within the watershed. The Similkameen River water is used for irrigation, drinking, livestock watering, primary and secondary-contact recreation, and industrial use, and sustains aquatic life and wildlife.

The main potential human influences on water quality include: treated municipal sewage from the communities of Princeton and Keremeos; an old copper mine (also used at times as a mushroom facility and a coal drying plant) that borders the Similkameen River just upstream from Princeton but actually discharged into Wolfe Creek (which drains to the Similkameen River between Princeton and Hedley); old mines in the Hedley area including one that drained to the river via Cahill Creek, agriculture, and forestry.

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 (including agriculture, ranching and historic mining). The Similkameen River supports healthy populations of salmonids and other fish species. It is unlikely that they 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 have the most influence on water quality.

- Water temperatures and dissolved oxygen concentrations also fluctuate throughout the year, with highest water temperatures occurring during the warmer summer months as would be expected. This also leads to the lowest dissolved oxygen concentrations during such periods, but this is expected because warmer water has a lesser capability to hold dissolved oxygen than colder water. Dissolved oxygen concentrations are considered to be at levels that will support healthy aquatic life populations.
- 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 regularly exceed the guideline for source waters used for drinking that are not treated other than by disinfection. These higher values occurred generally during freshet when turbidity levels are highest. If solids removal was used to treat this source water, then fecal coliforms would likely be removed and could be effectively disinfected during such periods.
- High levels of true and apparent colour are associated with the same high solids events as the metals noted above, 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.
- 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.
- Very rarely, some values for the following variables also exceeded guidelines: weak-acid dissociable cyanide, fluoride, and temperature. This rare occurrence of values in excess of guidelines is not a concern for the river water quality.

- There did not appear to be any visible long-term trends of increasing or decreasing values through the period of record at this station.

RECOMMENDATIONS

We recommend monitoring be continued for the Similkameen River at the U.S. Border since it is a transboundary site on a very important water body that is under pressure from human development. It is also the last site in Canada to monitor water quality before the river combines with the Okanagan River in Washington State.

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 graphs in this report were prepared by Sacha Wassick of Environment Canada. The draft report was reviewed by 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, B.C. Ministry of Environment and Environment Canada have been cooperatively measuring water quality at a number of locations in British Columbia. The primary 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 headwaters of the Similkameen River are in the Cascade Mountains. The river flows in a north-easterly direction from Manning Park to Princeton, and then south-easterly until it crosses the U.S. Border just south from Cawston (Figure 1). The river enters the Okanagan River downstream from Osoyoos Lake in Washington State.

There are four major population centres (Princeton, Hedley, Keremeos and Cawston) within the watershed. The area of the Canadian portion of the drainage basin is about 9,190 km^2. The main potential human influences on water quality include: treated municipal sewage from Princeton and Keremeos; an old copper mine (also used at times as a mushroom facility and a coal drying plant) that borders the Similkameen River just upstream from Princeton but actually discharged into Wolfe Creek (which drains to the Similkameen River between Princeton and Hedley); old mines in the Hedley area including one that drained to the river via Cahill Creek, agriculture and forestry.

The federal site number is BC08NL0005 and the provincial station number is 0500073 This site is located at 49° 04' 46" N: 119° 42' 28" W. Similkameen River water is used for irrigation, drinking, livestock watering, primary and secondary-contact recreation, and industrial use, and sustains aquatic life and wildlife.

This assessment is based on up to 28 years of water quality data collected during 1979-2006.

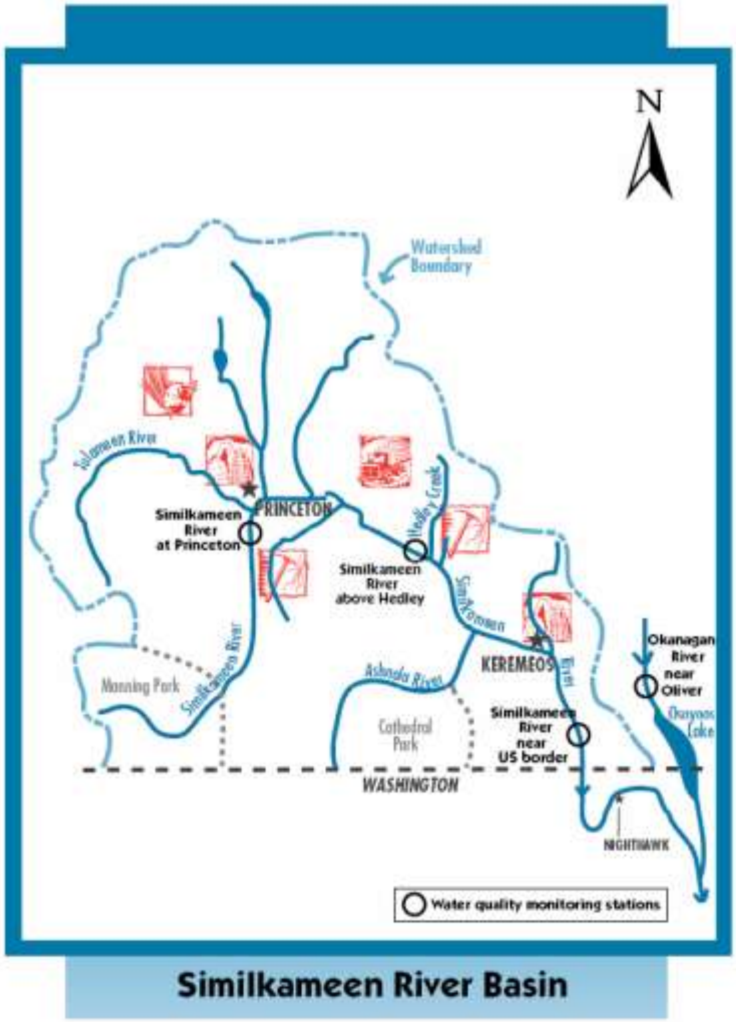


FIGURE 1: SIMILKAMEEN RIVER AT U.S. BORDER

WATER QUALITY ASSESSMENT

Data for the Similkameen River at the U.S. Border 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 to assess compliance with water quality objectives. In addition, quality assurance samples (blanks and replicates) are collected three 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.

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 (B.C. 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.

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.

Some water quality indicators (bromine and lithium) were not discussed as they met all water quality guidelines (if guidelines exist) and showed no clearly visible trends.

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: antimony, barium (only during high turbidity events), beryllium, bismuth, gallium, lanthanum, manganese, niobium, phosphorus, rubidium, non-filterable residue, selenium, tin, thallium, 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 (except during high turbidity events), boron, dissolved inorganic carbon, dissolved organic carbon, calcium, chloride, potassium, magnesium, molybdenum, total dissolved nitrogen, sodium, pH, filterable residue, silicon, silica, strontium, dissolved sulphate, and uranium.

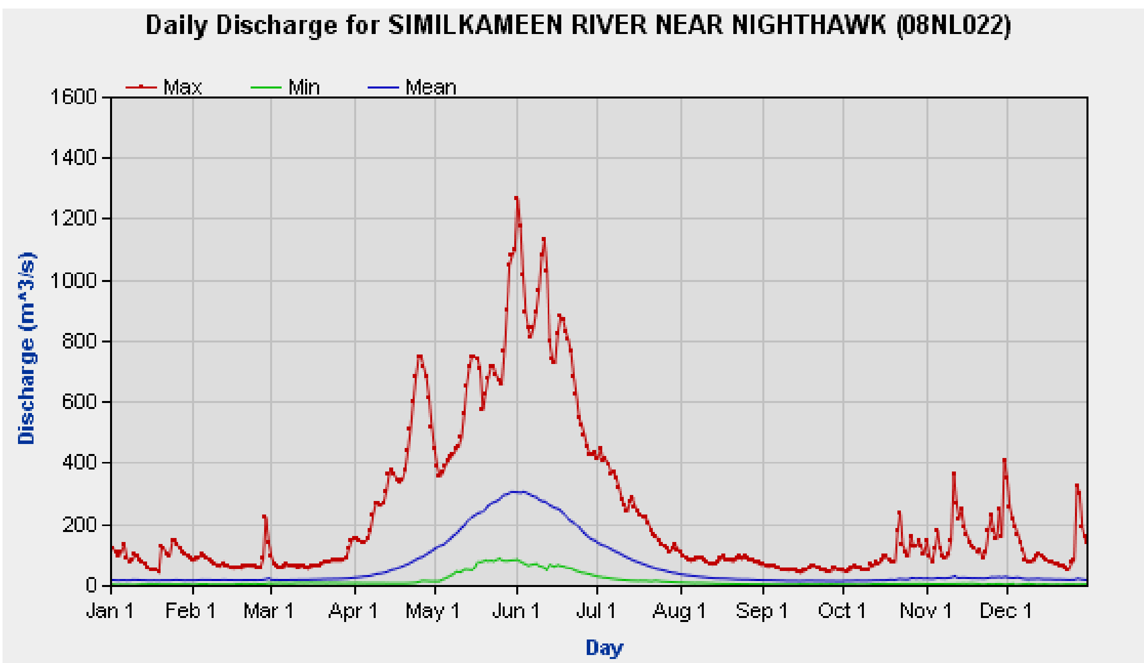


FIGURE 2: WATER SURVEY OF CANADA FLOW DATA FOR SIMILKAMEEN RIVER AT U.S. BORDER

Flow (Figure 2) followed typical patterns of interior British Columbia river systems, with peak flows occurring between late April and July and lower flows for the remainder of the year. Peak flows typically are in the order of 300 m^3/s although flows as high as about 1200 m^3/s have been recorded.

Aluminum (Figure 3) concentrations when measured as total and extractable regularly exceed the guideline for dissolved aluminum to protect aquatic life. These values that exceed guidelines generally occur during periods of freshet when turbidity levels are high. As such, the aluminum is likely in particulate form and not biologically available.

Alkalinity (Figure 4) values fluctuate throughout the year, with highest concentrations during the winter periods when ground water would have its greatest influence on water quality and with the lowest values recorded during freshet periods. Overall the river at the site is quite well-buffered.

Arsenic (Figure 6) values (total levels) occasionally exceeded both the guideline of 5 µg/L to protect aquatic life and 25 µg/L to protect source waters used for drinking. These values usually were recorded during freshet periods when turbidity would be elevated and the arsenic would likely be in the particulate matter. At such times, it would not be biologically available nor would it remain after solids removal for drinking water supplies. Dissolved values collected during turbid periods indicate that dissolved arsenic is always below these guidelines.

Cadmium (Figure 15) values occasionally exceeded the guideline to protect aquatic life, even after 2003 when much lower detection limits were used. The high values usually corresponded to higher turbidity levels, meaning that the cadmium was in particulate form and not likely biologically available.

Chloride (Figure 16) exhibited a visually increasing trend over the period of record until 1999, when chloride analysis at the site was discontinued due to budget pressures. This analysis should be re-instated as chloride is now known to be a useful variable for tracking human impacts, particularly in urbanized areas.

Cyanide (Figure 17) values when measured as weak-acid dissociable had detection limits of about 500 µg/L that are higher than the 10 µg/L guideline values for maximum concentrations. Some weak-acid dissociable values did exceed the detection limit and therefore also the guideline; however, only values greater than ten times higher than the detection limit would be of real concern (due to potential measurement errors) and such high values were only recorded in 1992 and 1993. Efforts should be made to obtain data using much lower detection limits, if available.

Cobalt (Figure 19) values (individual) infrequently exceeded the aquatic life guideline for the 30-day average concentration. These high individual values were correlated with elevated turbidity, meaning that the cobalt was likely in particulate form and not biologically available.

Colour (Figure 20) values when measured as both true and apparent colour have exceeded the drinking water guideline; however, these higher values are associated with high turbidity events and it is expected that water treatment facilities required to remove turbidity would also reduce colour levels appreciably. Colour is an aesthetic concern for drinking water and not a health issue.

Chromium (Figure 21) values occasionally exceeded the guideline for both trivalent chromium and hexavalent chromium to protect aquatic life. The higher chromium concentrations were associated with higher turbidity concentrations and were likely not biologically available.

Copper (Figure 22) values occasionally exceeded the guidelines to protect aquatic life; however, these higher values were correlated with high turbidity levels indicating that the copper was likely in particulate form and not biologically available.

Dissolved Oxygen (Figure 23) concentrations were generally, as expected, inversely related to temperatures meaning that at lower temperatures, dissolved oxygen levels were highest.

Fluoride (Figure 24) values generally were lower than guidelines to protect aquatic life. One total value exceeded the guideline in 1994. This value was recorded when higher analytical detection limits were used for measuring concentrations is within ten times of that detection limit. No values have exceeded the guidelines since lower detection limits have been used. Therefore, the value that exceeded guideline was likely related to the detection limits and therefore likely not an accurate value.

Iron (Figure 25) regularly exceeded the guidelines to protect aquatic life and source water used for drinking; however, both total and extractable concentrations were correlated with higher turbidity levels, meaning that the iron was likely in particulate form and not biologically available. Additionally, iron would be removed in any treatment process used to remove solids.

Fecal Coliforms (Figure 26) regularly exceeded the guideline for source waters used for drinking that are not treated other than with disinfection. These higher values occurred during freshet when turbidity levels would be higher. During such periods, turbidity removal should be used to treat the source water, and this would likely remove the higher fecal coliform levels and make disinfection more effective.

Hardness (Figure 28) values occasionally exceeded the guideline for source waters used for drinking that hardness should be in the 80 mg/L to 100 mg/L range. These higher values were recorded during the late autumn or winter when the influence of ground water inflows on stream water quality would be greatest. Hardness concentrations were also correlated with specific conductivity values.

Lead (Figure 31) values fluctuated with turbidity but individual values occasionally exceeded the guidelines for 30-day mean values to protect aquatic life. Analytical detection limits have improved substantially since the beginning of 2003 with the result that fewer values have exceeded guidelines since then. The high total lead values are likely reflecting that the lead is in particulate form during those periods and likely is not biologically available.

Nitrate plus nitrite (Figures 36 and 37) nitrogen values occasionally exceeded the aquatic life guideline for nitrite alone; however, it is likely that the values reflect nitrate concentrations (which met guidelines) because nitrite would be quickly oxidized to form nitrate.

Nickel (Figure 42) values occasionally exceeded the aquatic life guideline; however, these higher values were correlated with high turbidity levels that implies that the nickel was in particulate form and not biologically available.

Silver (Figure 54 and 55) appeared to occasionally exceed the guidelines for the protection of aquatic life until 2003; however, the frequency of the values exceeding the guideline was reduced considerably when the analytical detection limit was reduced significantly. The earlier values that exceeded the guideline may have been “noise” associated with the detection limit. Silver values do appear to correlate with higher turbidity values, meaning that even if the high values were valid, that the silver was likely in particulate form and not biologically available.

Specific Conductivity (Figure 57) fluctuates on a yearly basis, with the highest values being recorded during low flows when the influence of ground water would be greatest on water quality, and lowest values being during freshet.

Temperature (Figure 60) of the water fluctuated as expected throughout the year, with maximum temperatures being experienced during the hot summer months. The guideline for the maximum average weekly temperatures for streams with unknown fish distributions was exceeded marginally on a couple of instances. The recorded temperatures represent instantaneous measurements; actual weekly average temperatures were slightly lower than these values.

Turbidity (Figure 62) fluctuates throughout the year, with highest values usually associated with freshet. On occasion, high values can also occur at other times of year, for example during high rainfall events.

Zinc (Figure 65) occasionally had individual values exceed the guideline for the 30-day mean concentration. Zinc concentrations were correlated with turbidity, meaning that the zinc was likely in particulate form and not biologically available.

References

Ministry of Environment. 2006a. British Columbia Approved Water Quality Guidelines (Criteria). Environmental Protection Division, Ministry of Environment. Victoria, B.C.

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.

Figure 3
Similkameen River near U.S. Border
Aluminum Dissolved, Total and Extractable

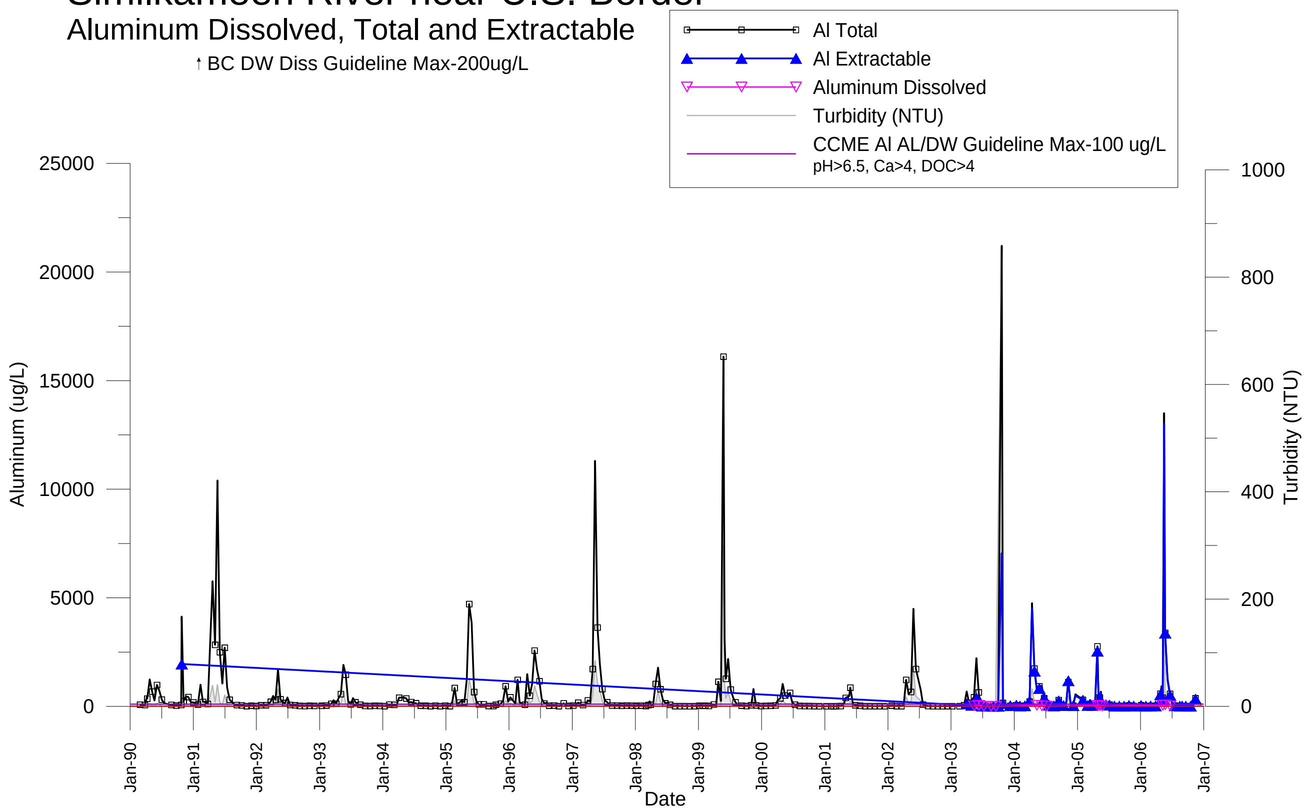


Figure 4
Similkameen River near U.S. Border
Alkalinity Total

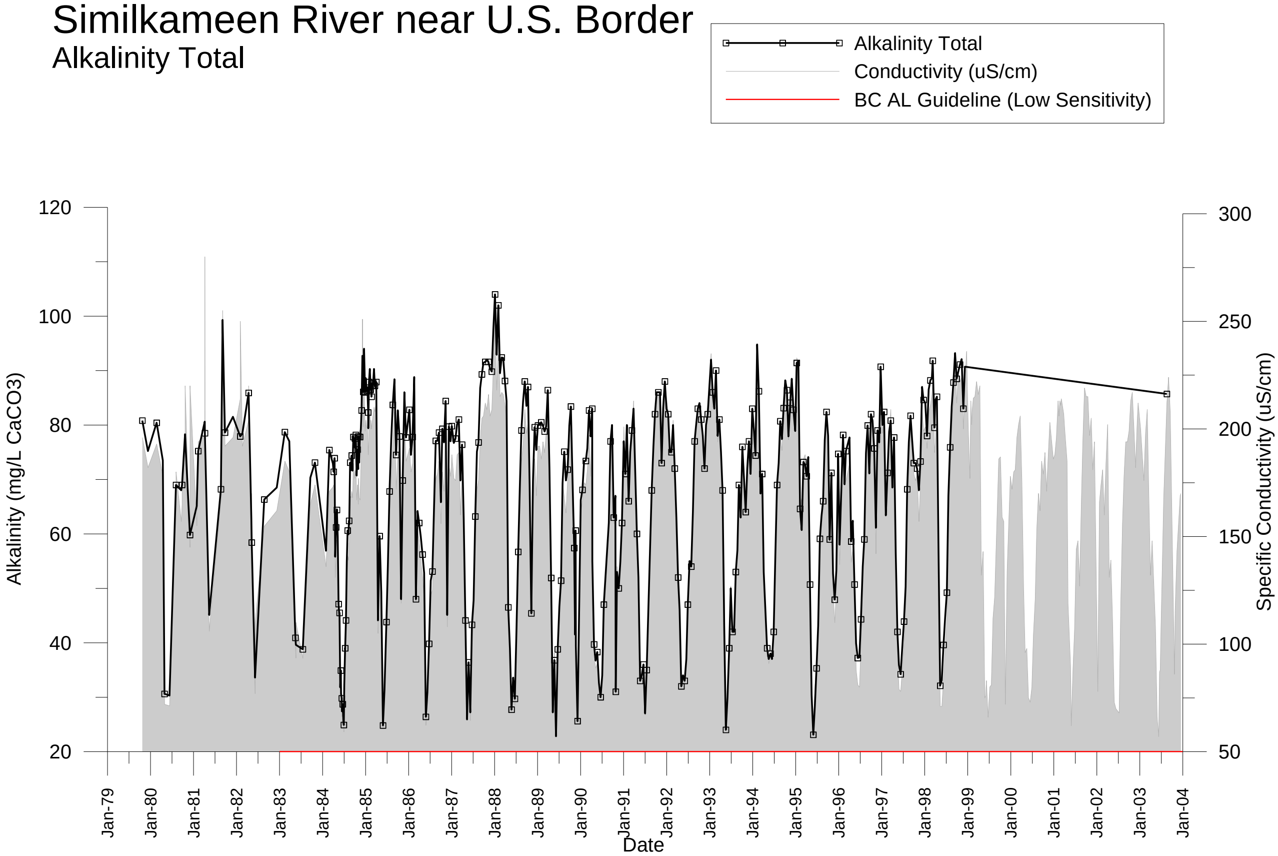
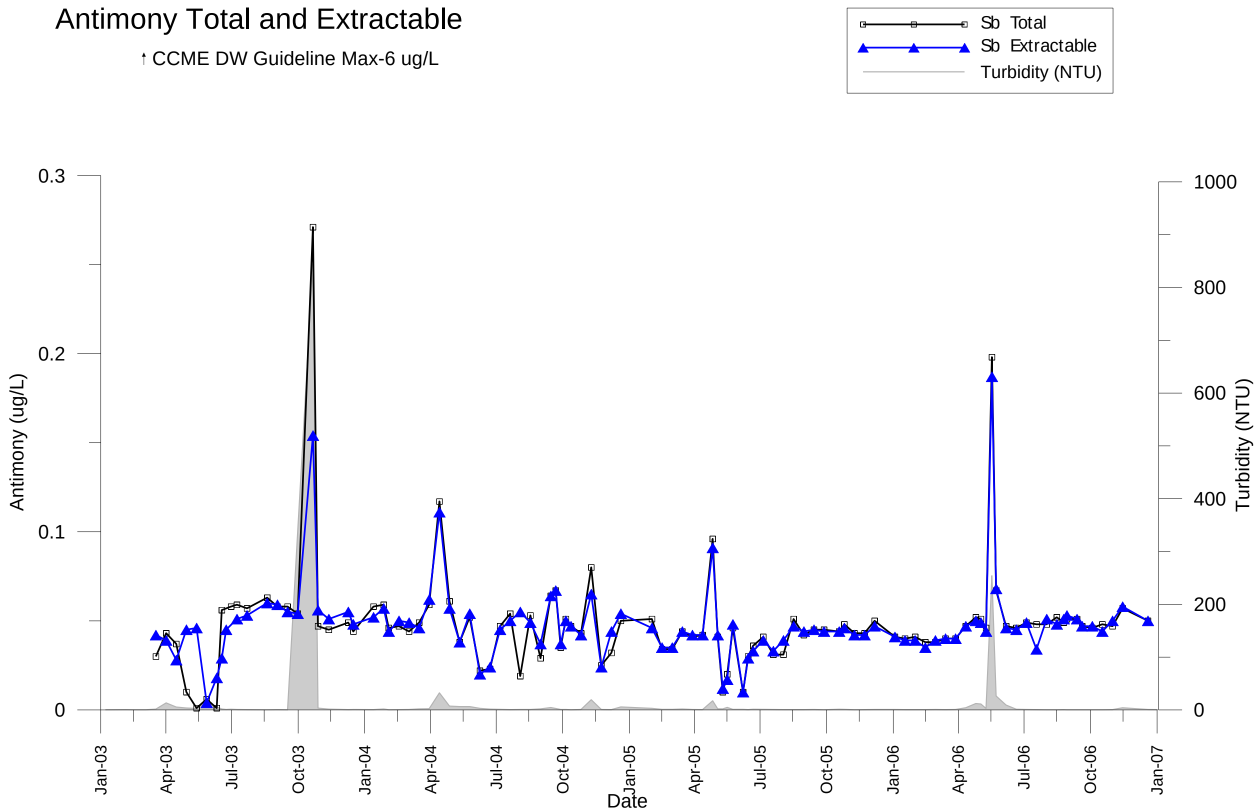


Figure 5
Similkameen River near U.S. Border
Antimony Total and Extractable

↑ CCME DW Guideline Max-6 ug/L



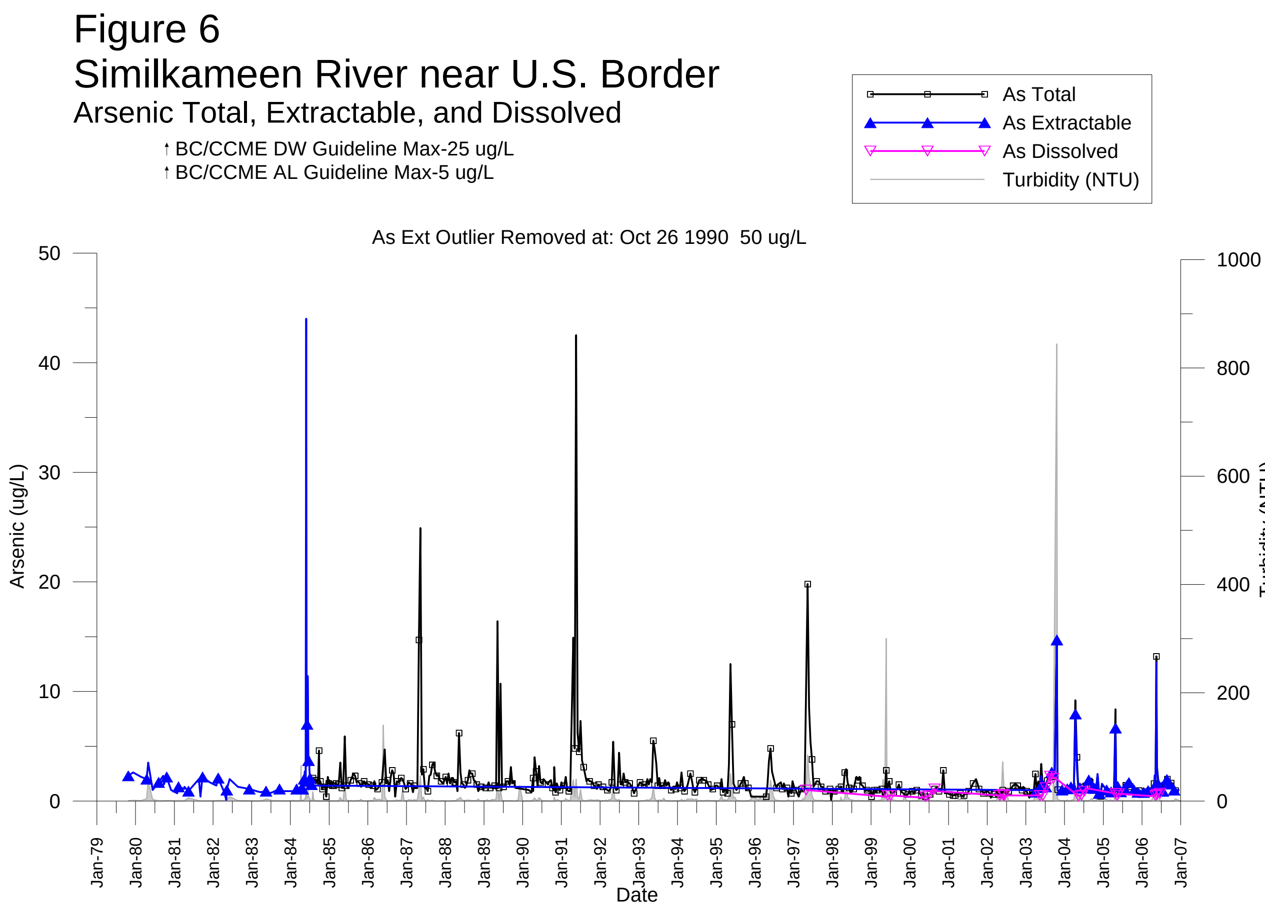
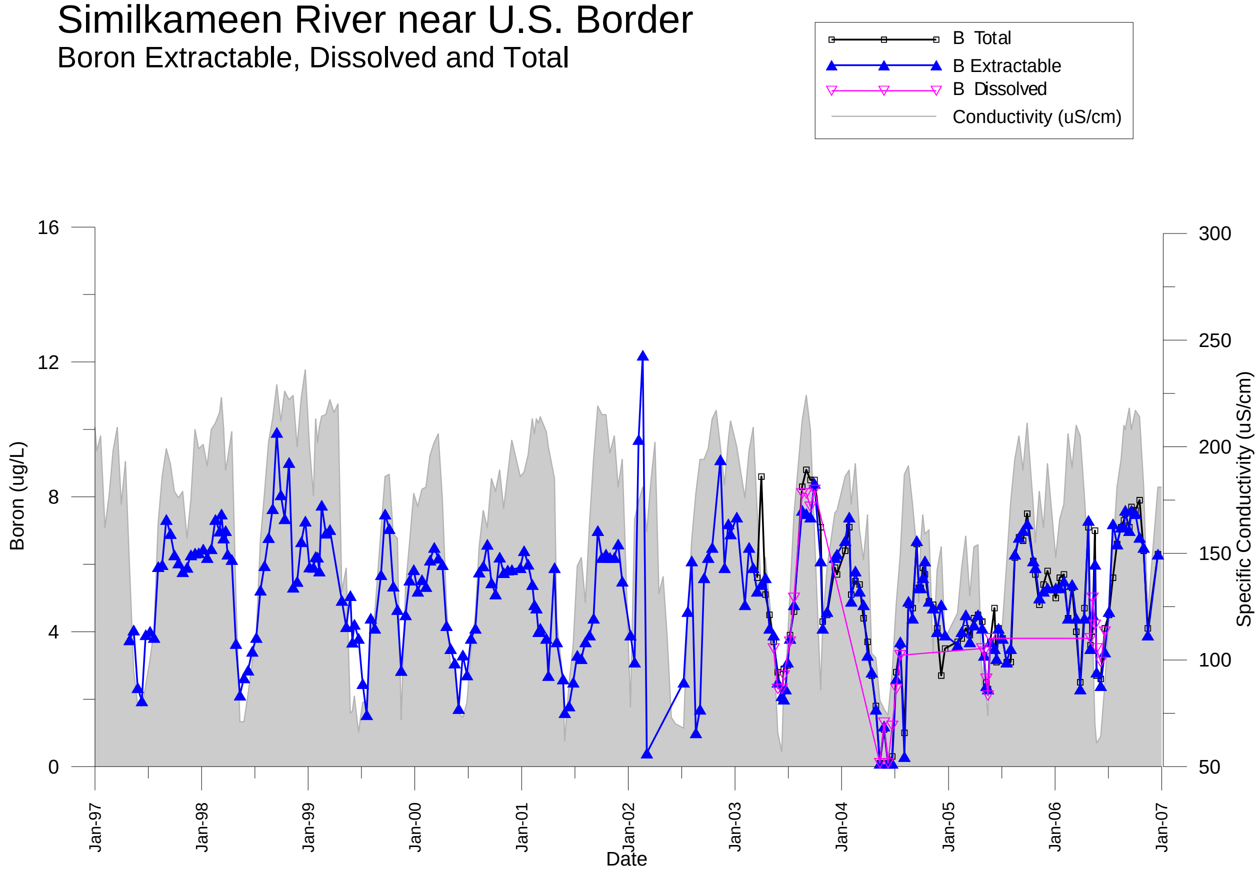


Figure 6
Similkameen River near U.S. Border
Arsenic Total, Extractable, and Dissolved
BC/CCME DW Guideline Max-25 ug/L
BC/CCME AL Guideline Max-5 ug/L
As Total
As Extractable
As Dissolved
Turbidity (NTU)
As Ext Outlier Removed at: Oct 26 1990 50 ug/L
Arsenic (ug/L)
Turbidity (NTU)
Date
0
10
20
30
40
50
200
400
600
800
1000
Jan-79
Jan-80
Jan-81
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07

Figure 7
Similkameen River near U.S. Border
Boron Extractable, Dissolved and Total



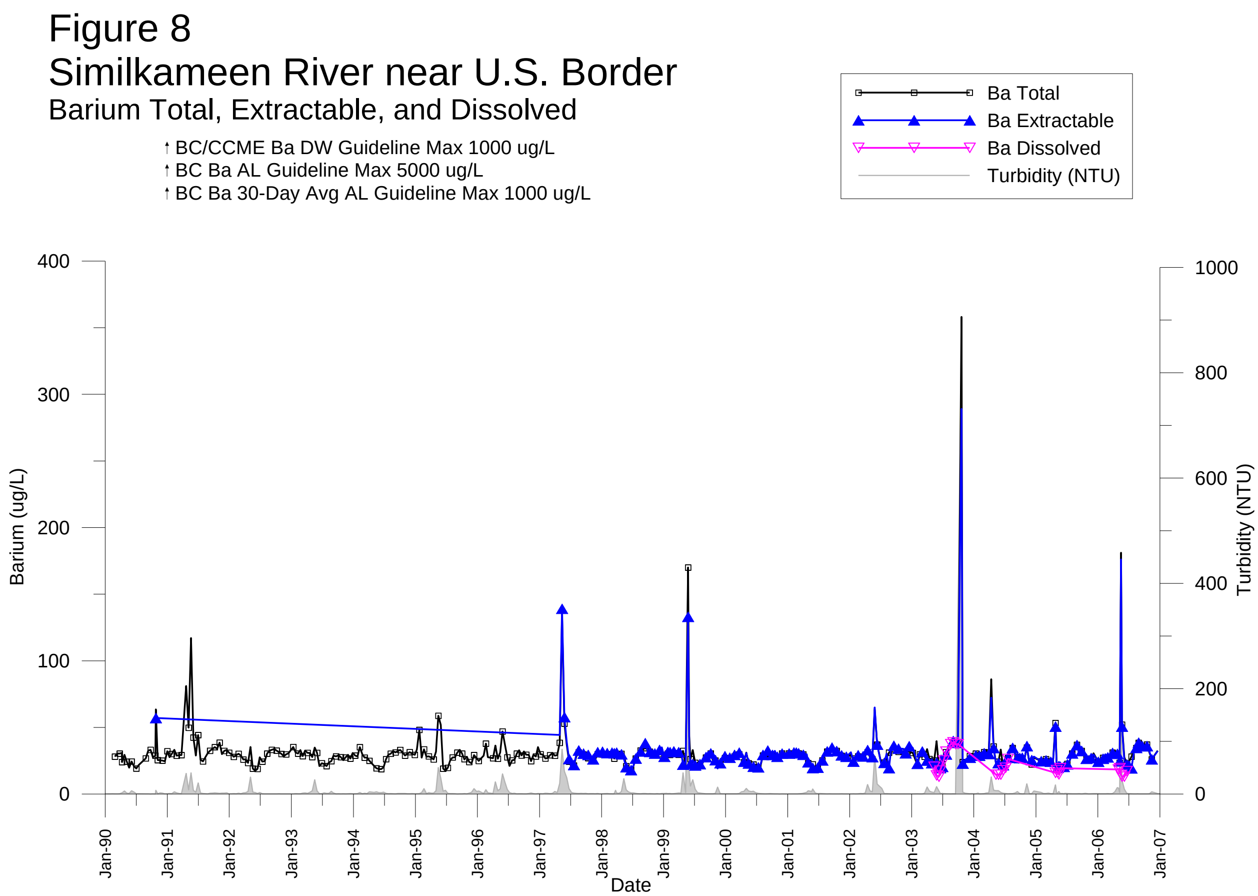


Figure 8
Similkameen River near U.S. Border
Barium Total, Extractable, and Dissolved
↑ BC/CCME Ba DW Guideline Max 1000 ug/L
↑ BC Ba AL Guideline Max 5000 ug/L
↑ BC Ba 30-Day Avg AL Guideline Max 1000 ug/L
Ba Total
Ba Extractable
Ba Dissolved
Turbidity (NTU)
Barium (ug/L)
Turbidity (NTU)
Date
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07

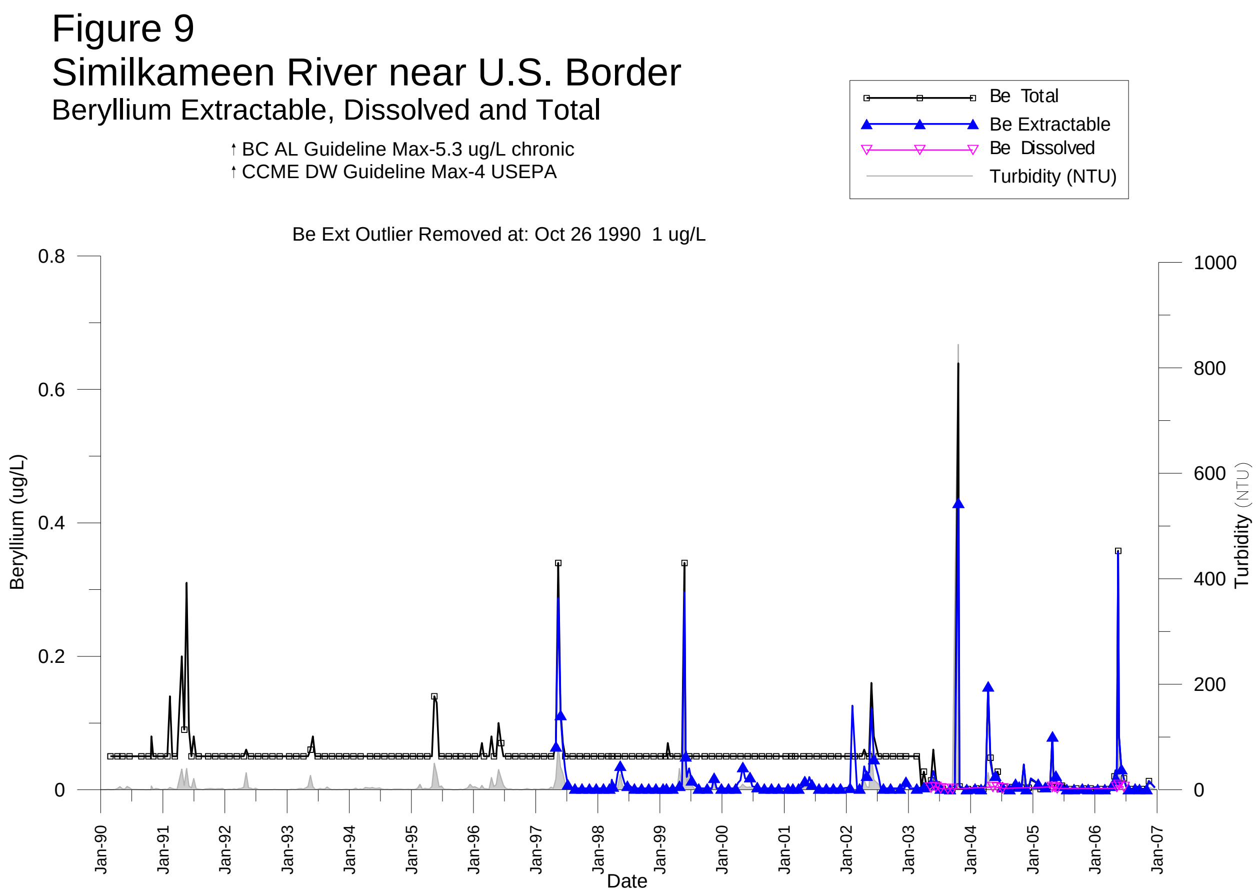
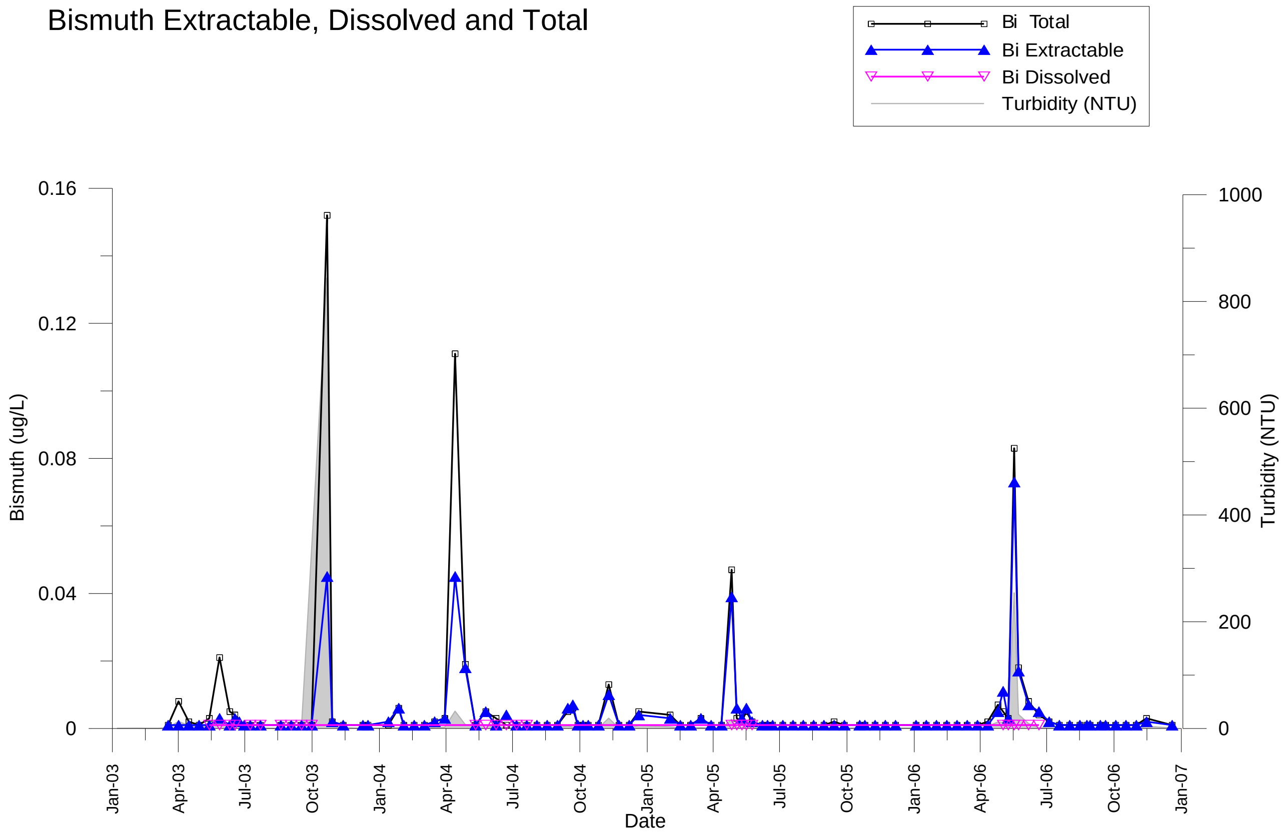


Figure 9
Similkameen River near U.S. Border
Beryllium Extractable, Dissolved and Total
↑ BC AL Guideline Max-5.3 ug/L chronic
↑ CCME DW Guideline Max-4 USEPA
Be Total
Be Extractable
Be Dissolved
Turbidity (NTU)
Be Ext Outlier Removed at: Oct 26 1990 1 ug/L
Beryllium (ug/L)
Turbidity (NTU)
Date
0.8
0.6
0.4
0.2
0
1000
800
600
400
200
0
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07

Figure 10
Similkameen River near U.S. Border
Bismuth Extractable, Dissolved and Total



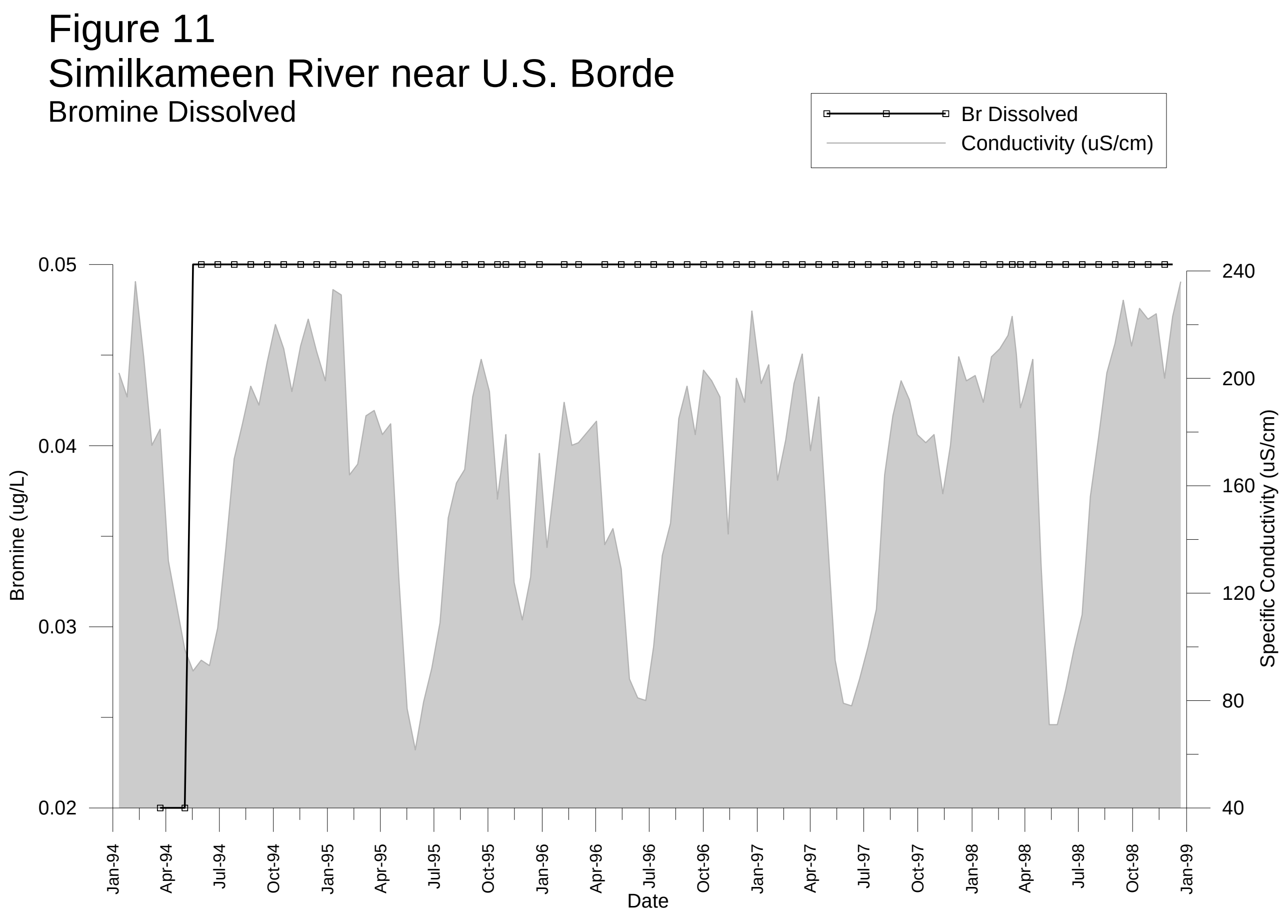


Figure 11
Similkameen River near U.S. Borde
Bromine Dissolved
Br Dissolved
Conductivity (uS/cm)
Bromine (ug/L)
0.05
0.04
0.03
0.02
Specific Conductivity (uS/cm)
240
200
160
120
80
40
Jan-94
Apr-94
Jul-94
Oct-94
Jan-95
Apr-95
Jul-95
Oct-95
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Date

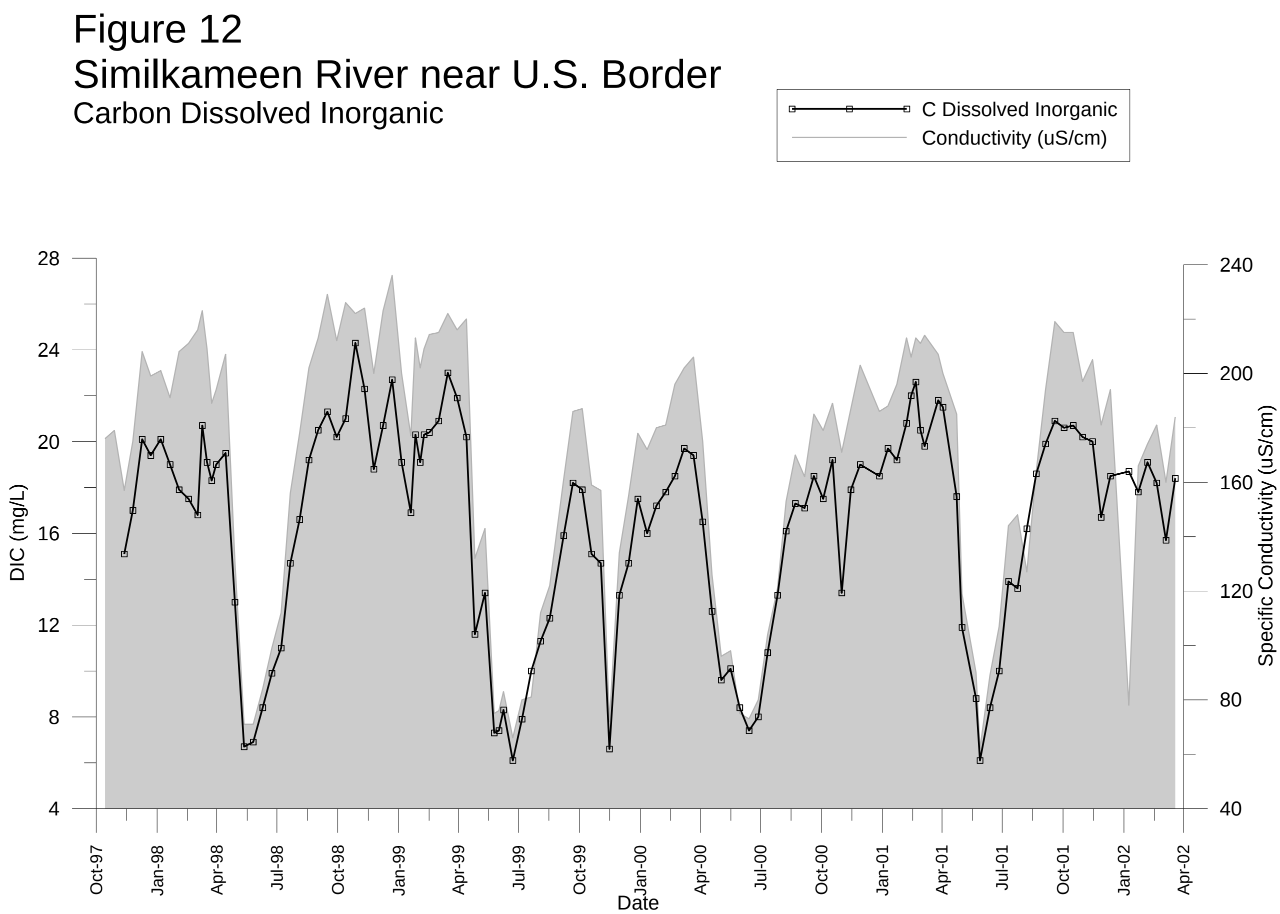


Figure 12
Similkameen River near U.S. Border
Carbon Dissolved Inorganic
C Dissolved Inorganic
Conductivity (uS/cm)
DIC (mg/L)
Specific Conductivity (uS/cm)
Date
28
24
20
16
12
8
4
240
200
160
120
80
40
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Apr-99
Jul-99
Oct-99
Jan-00
Apr-00
Jul-00
Oct-00
Jan-01
Apr-01
Jul-01
Oct-01
Jan-02
Apr-02

Figure 13
Similkameen River near U.S. Border
Carbon Dissolved Organic

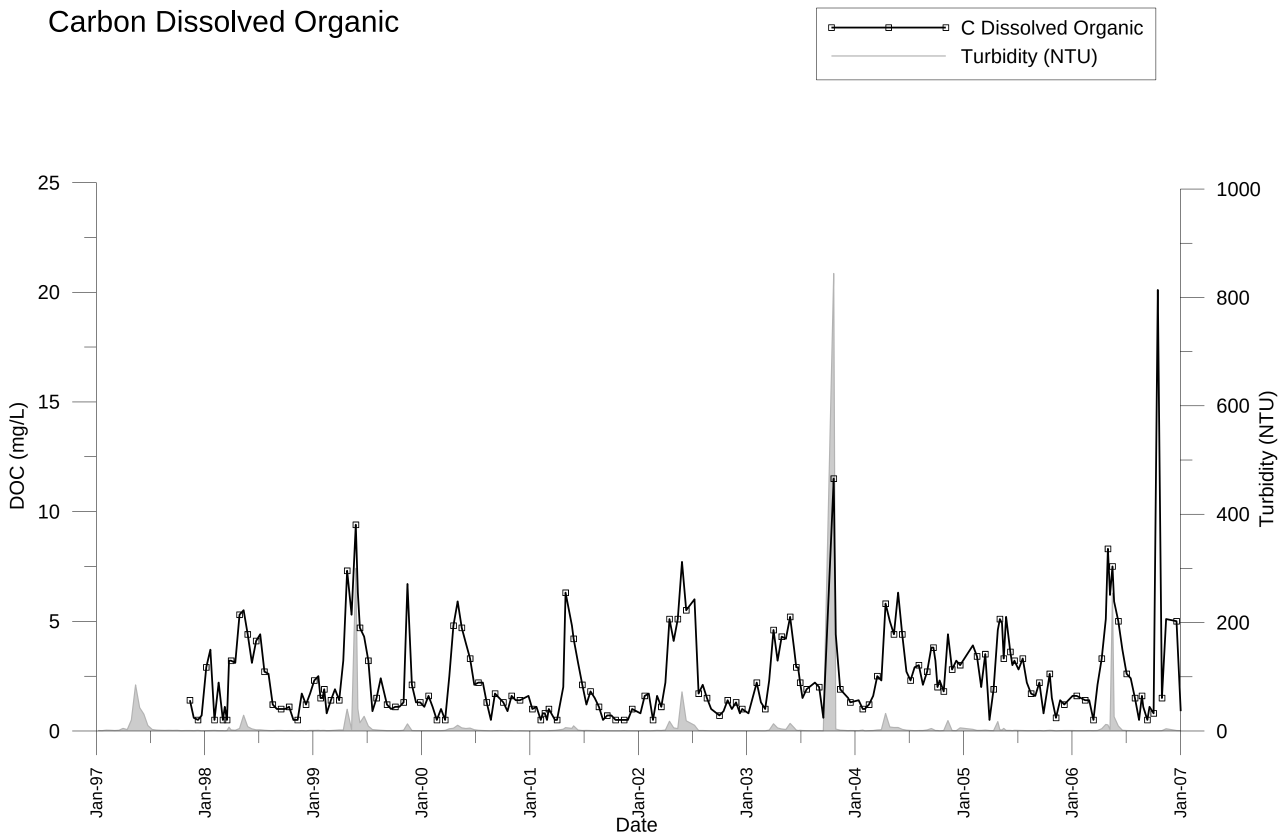
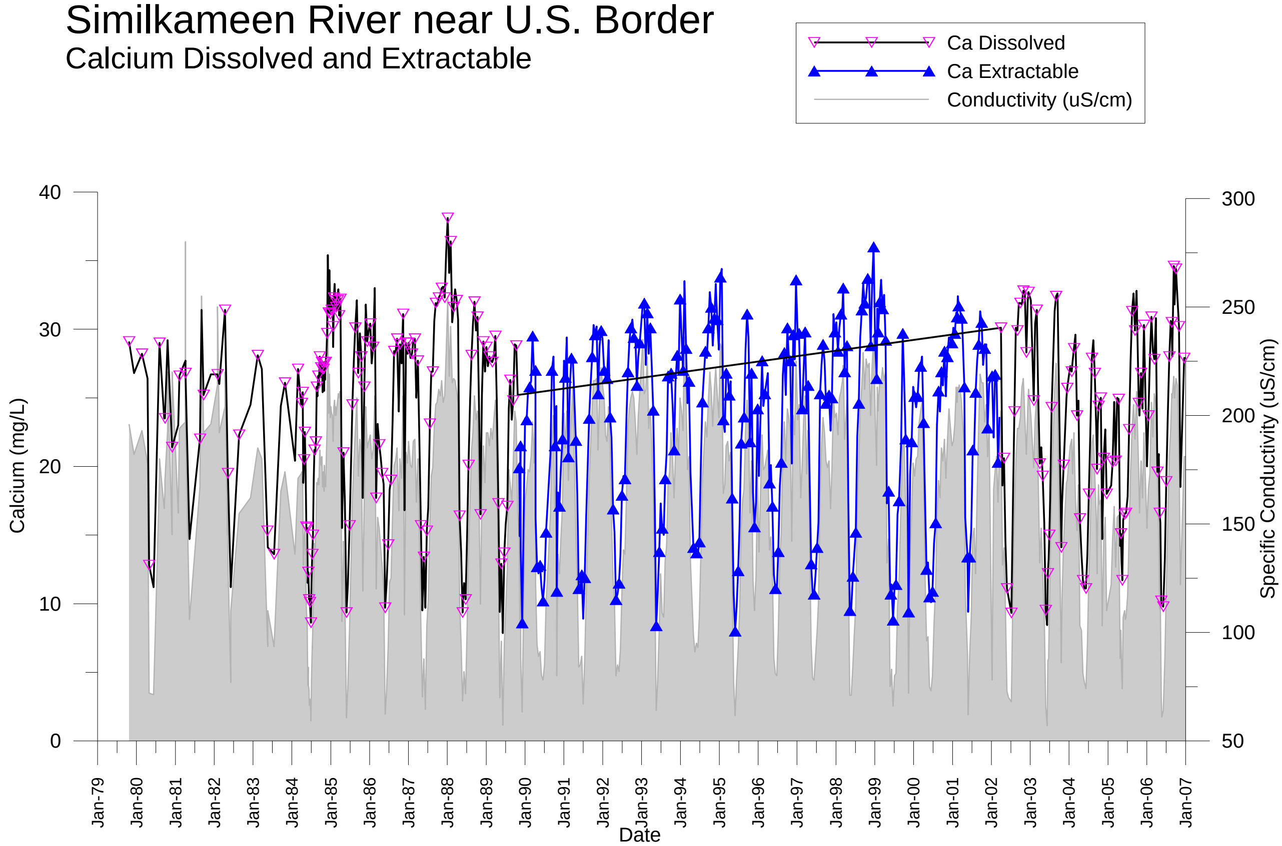


Figure 14
Similkameen River near U.S. Border
Calcium Dissolved and Extractable



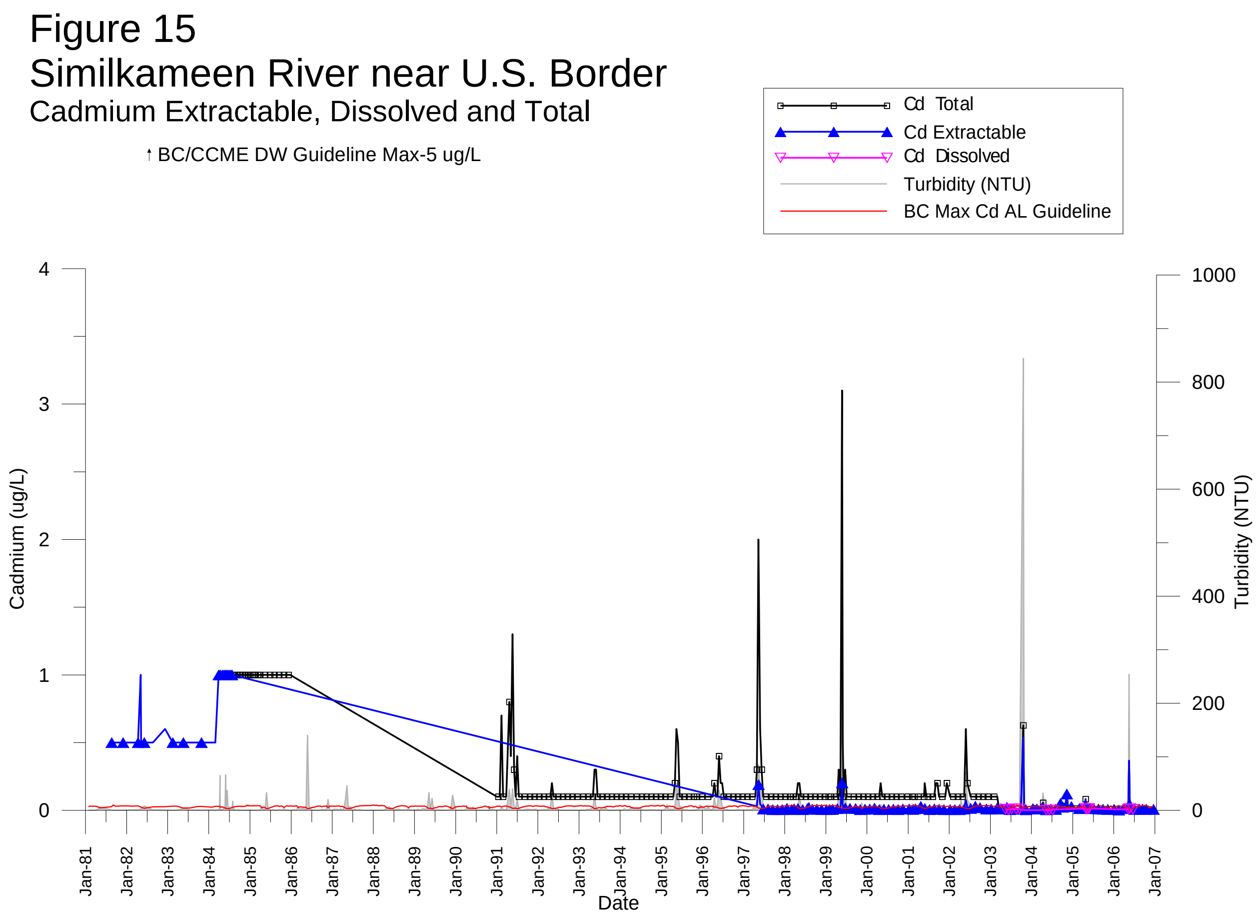


Figure 15
Similkameen River near U.S. Border
Cadmium Extractable, Dissolved and Total
↑ BC/CCME DW Guideline Max-5 ug/L
Cd Total
Cd Extractable
Cd Dissolved
Turbidity (NTU)
BC Max Cd AL Guideline
Cadmium (ug/L)
Turbidity (NTU)
Date
0
1
2
3
4
0
200
400
600
800
1000
Jan-81
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07

Figure 16
Similkameen River near U.S. Border
Chloride Dissolved

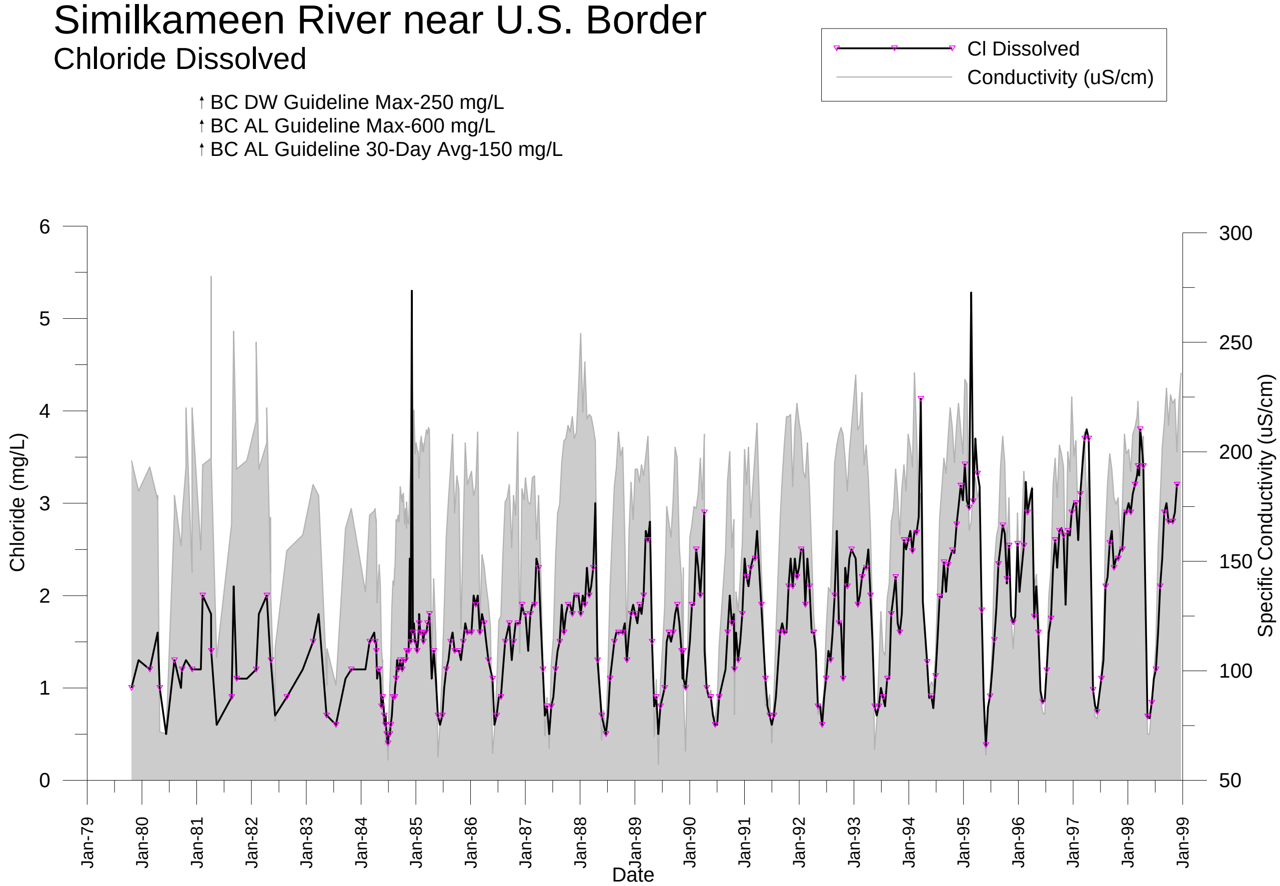


Figure 17
Similkameen River near U.S. Border
Cyanide Total and Weak Acid Dissociable

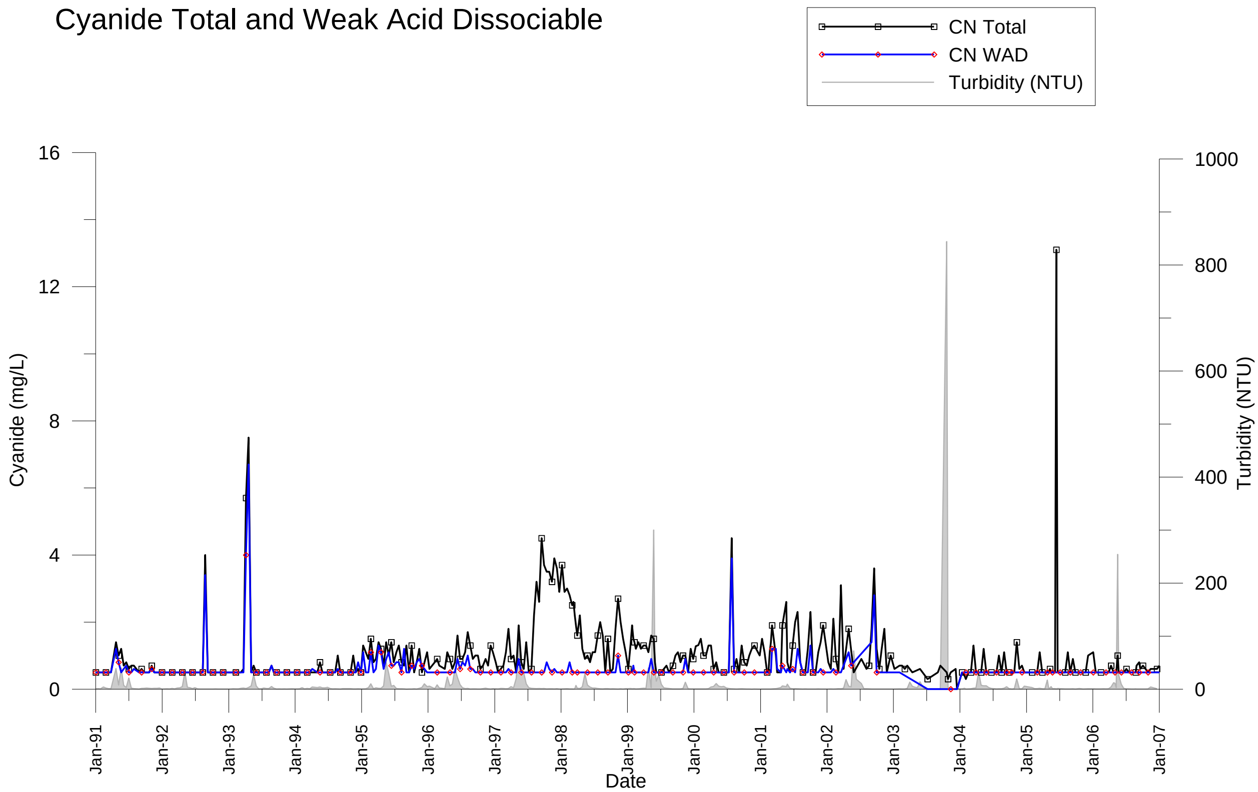
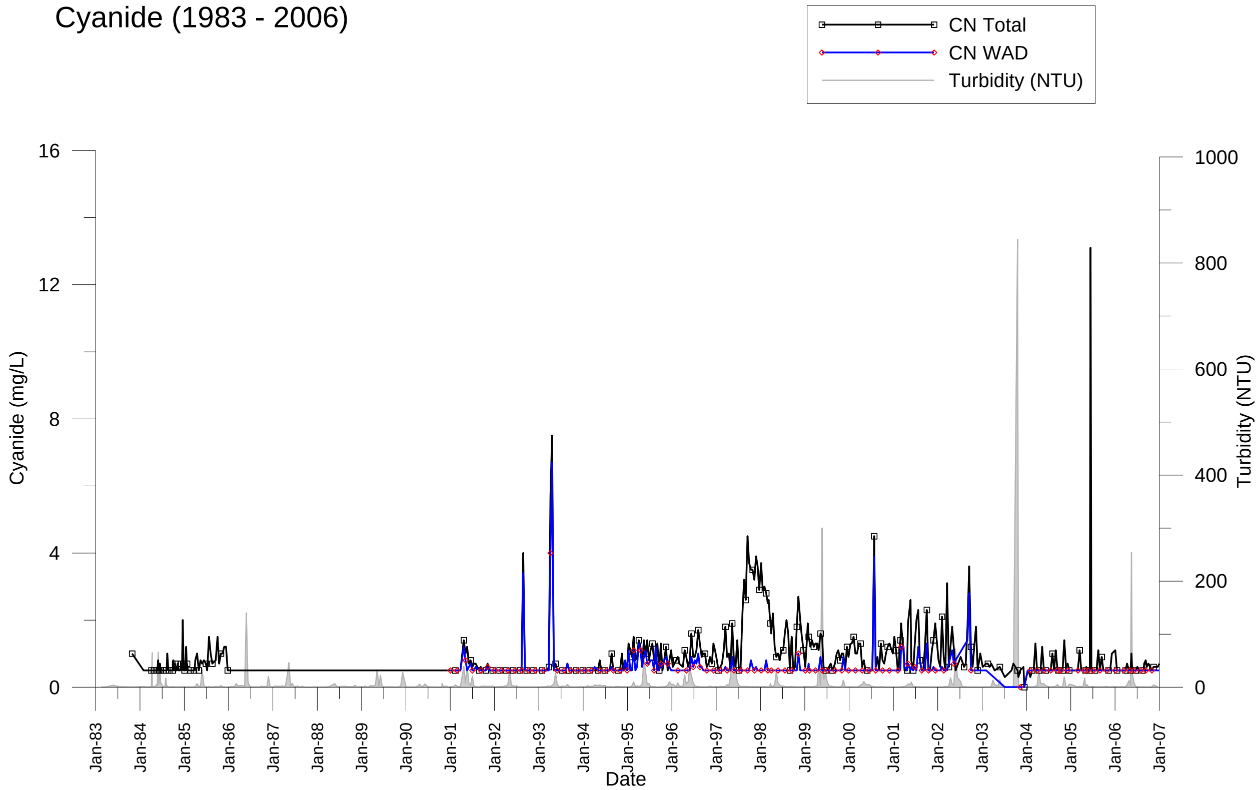


Figure 18
Similkameen River near U.S. Border
Cyanide (1983 - 2006)



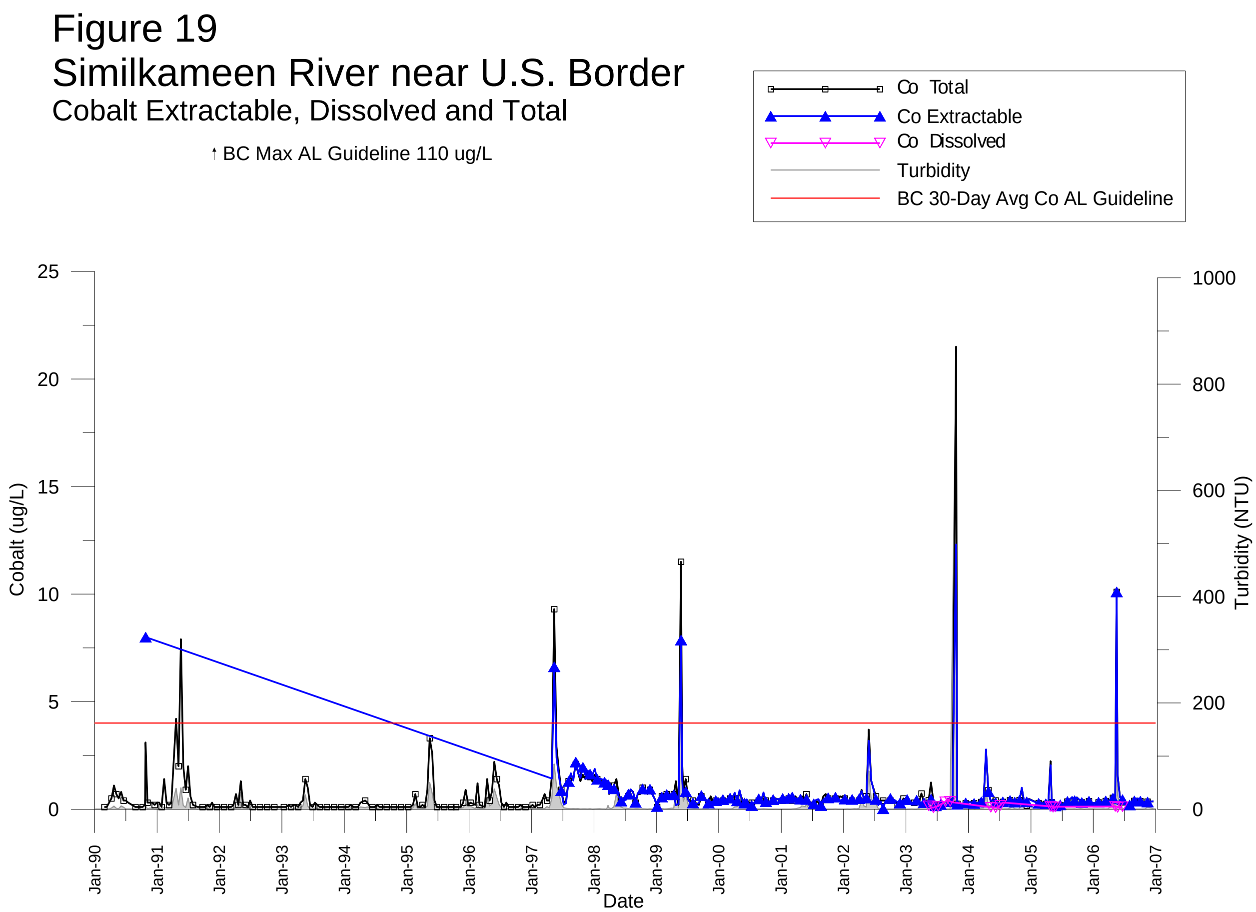
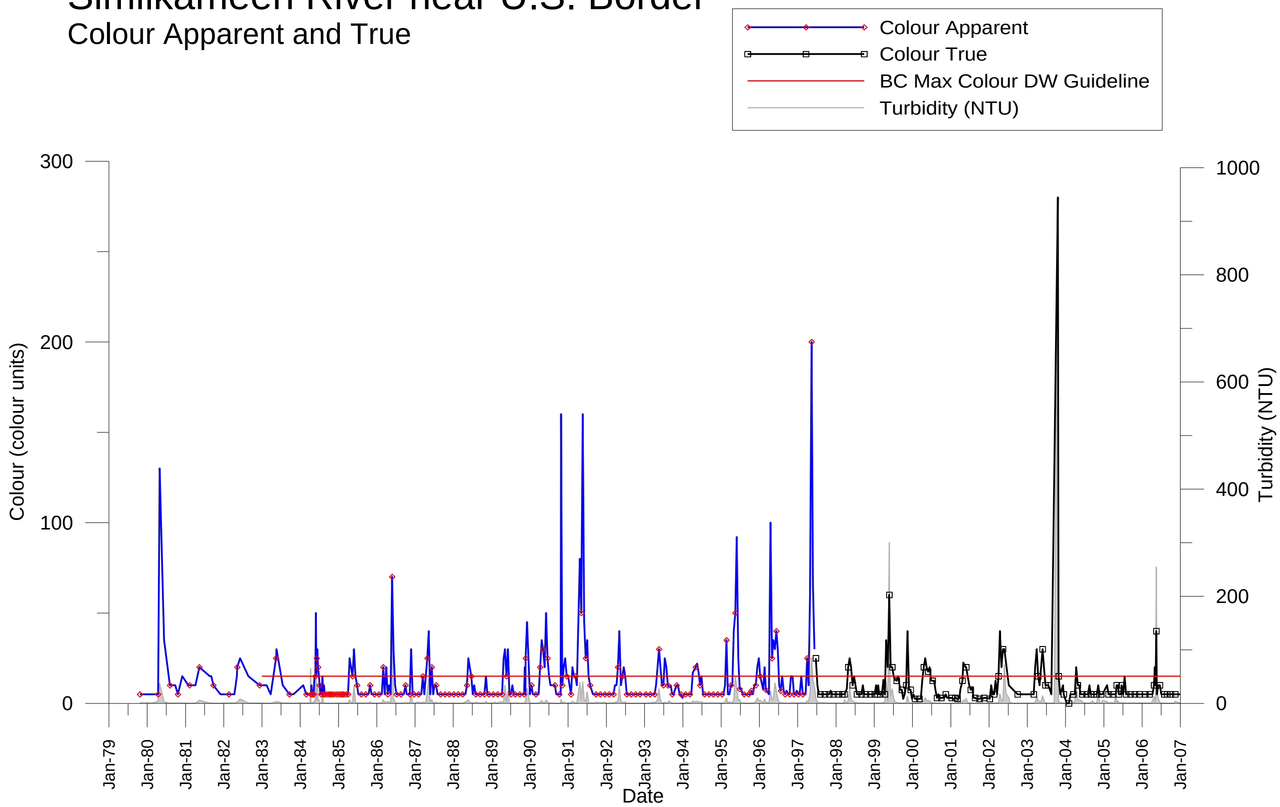


Figure 19
Similkameen River near U.S. Border
Cobalt Extractable, Dissolved and Total
↑ BC Max AL Guideline 110 ug/L
Co Total
Co Extractable
Co Dissolved
Turbidity
BC 30-Day Avg Co AL Guideline
Cobalt (ug/L)
Turbidity (NTU)
Date
0
5
10
15
20
25
0
200
400
600
800
1000
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07

Figure 20
Similkameen River near U.S. Border
Colour Apparent and True



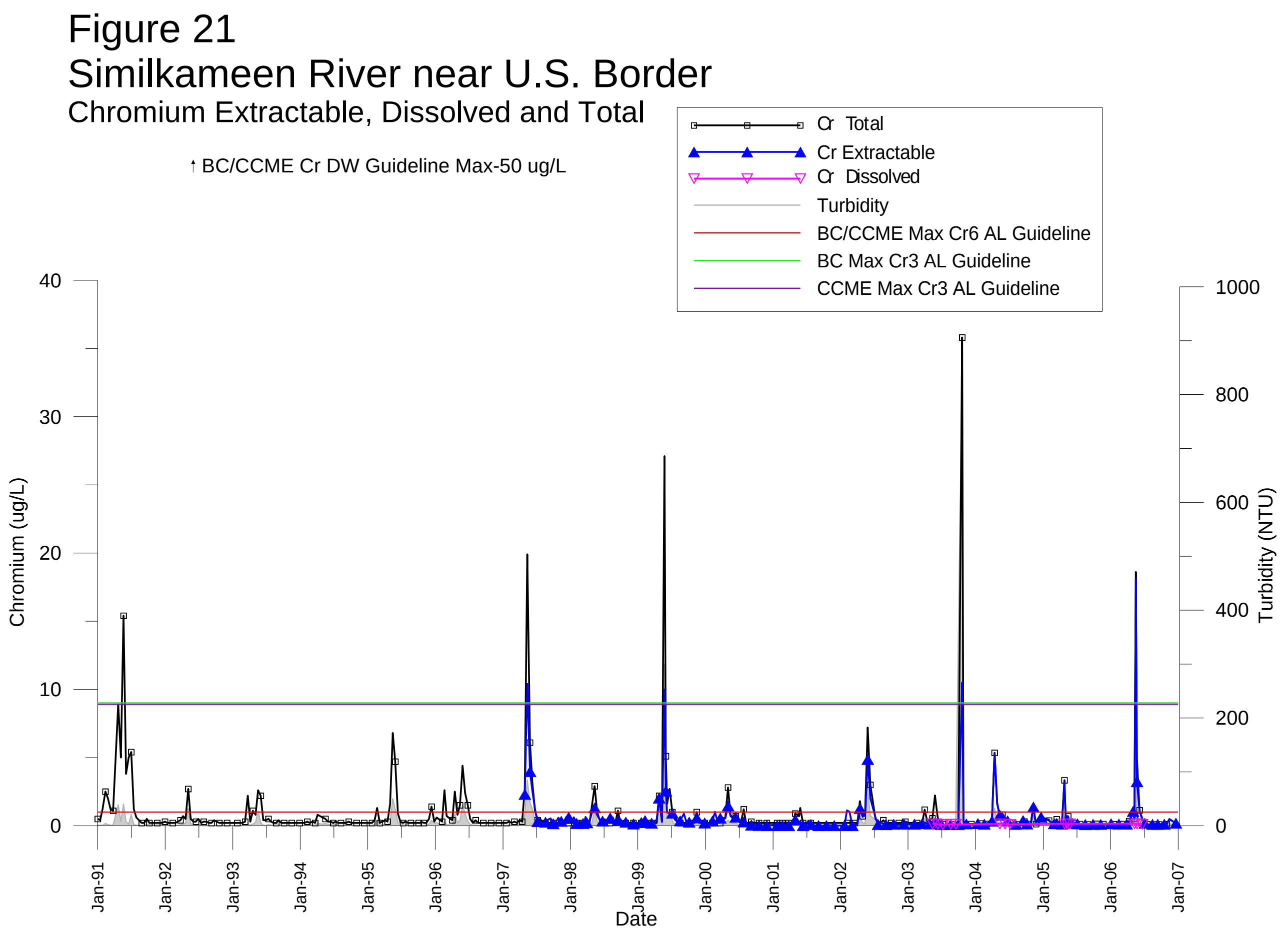
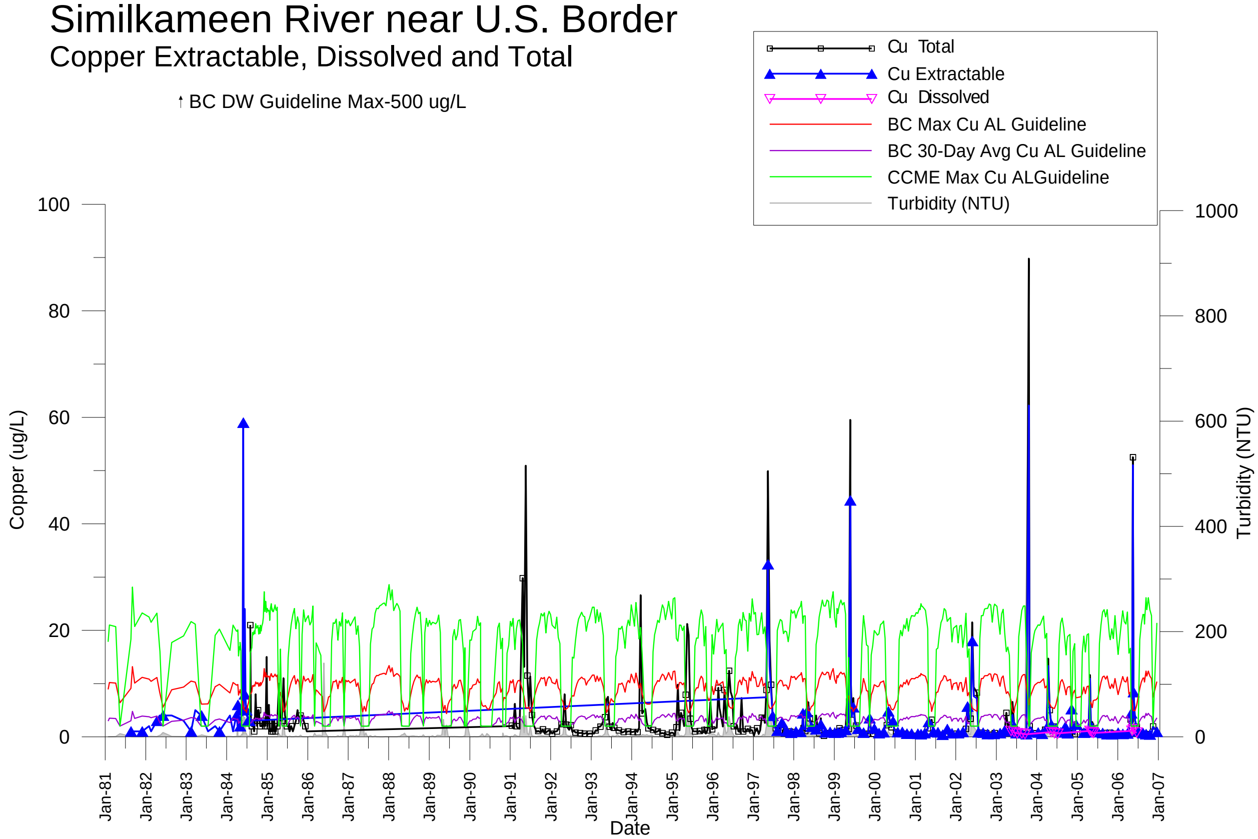


Figure 21
Similkameen River near U.S. Border
Chromium Extractable, Dissolved and Total
↑ BC/CCME Cr DW Guideline Max-50 ug/L
Cr Total
Cr Extractable
Cr Dissolved
Turbidity
BC/CCME Max Cr6 AL Guideline
BC Max Cr3 AL Guideline
CCME Max Cr3 AL Guideline
Chromium (ug/L)
Turbidity (NTU)
Date
0
10
20
30
40
0
200
400
600
800
1000
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07

Figure 22
Similkameen River near U.S. Border
Copper Extractable, Dissolved and Total



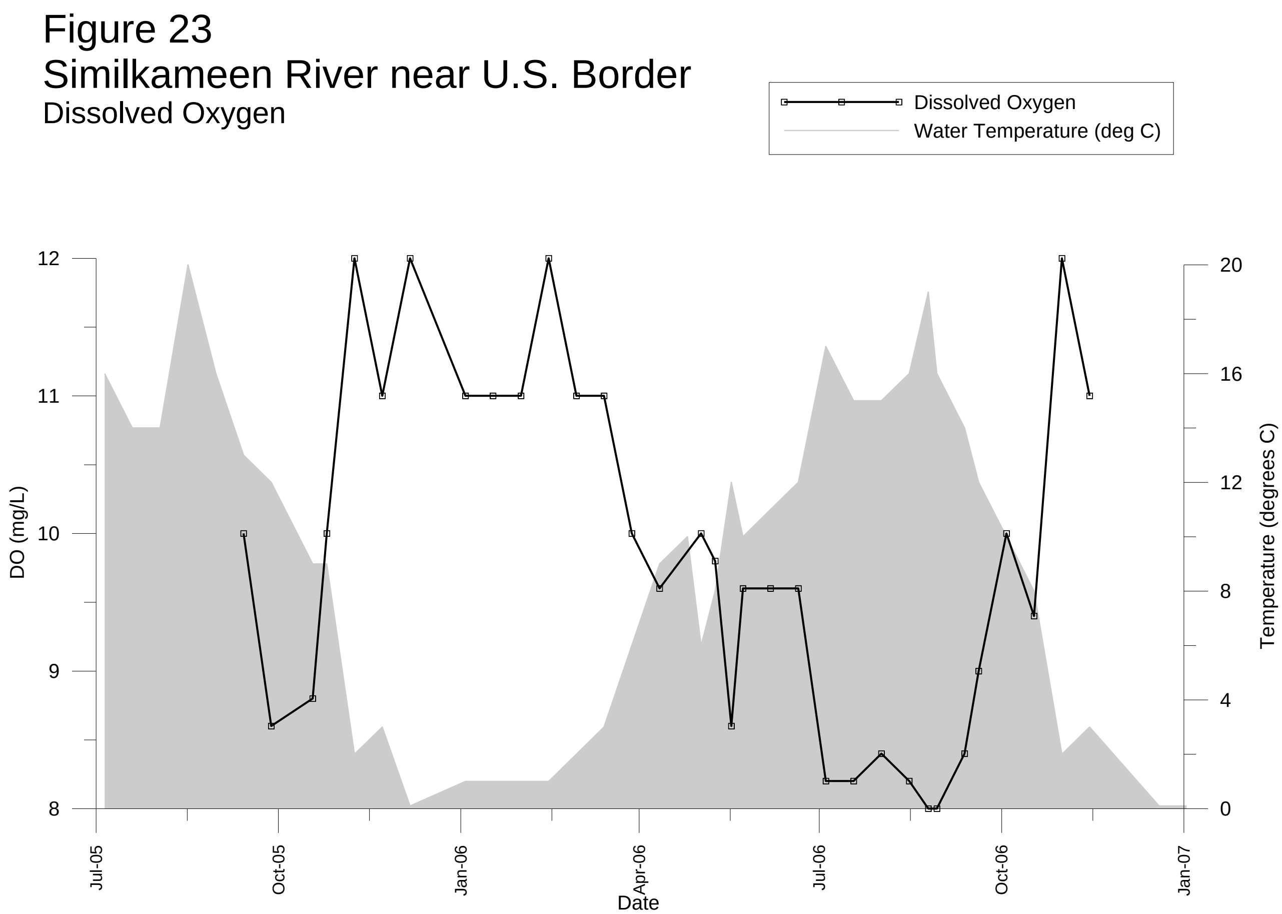


Figure 23
Similkameen River near U.S. Border
Dissolved Oxygen
Dissolved Oxygen
Water Temperature (deg C)
DO (mg/L)
12
11
10
9
8
Temperature (degrees C)
20
16
12
8
4
0
Jul-05
Oct-05
Jan-06
Apr-06
Jul-06
Oct-06
Jan-07
Date

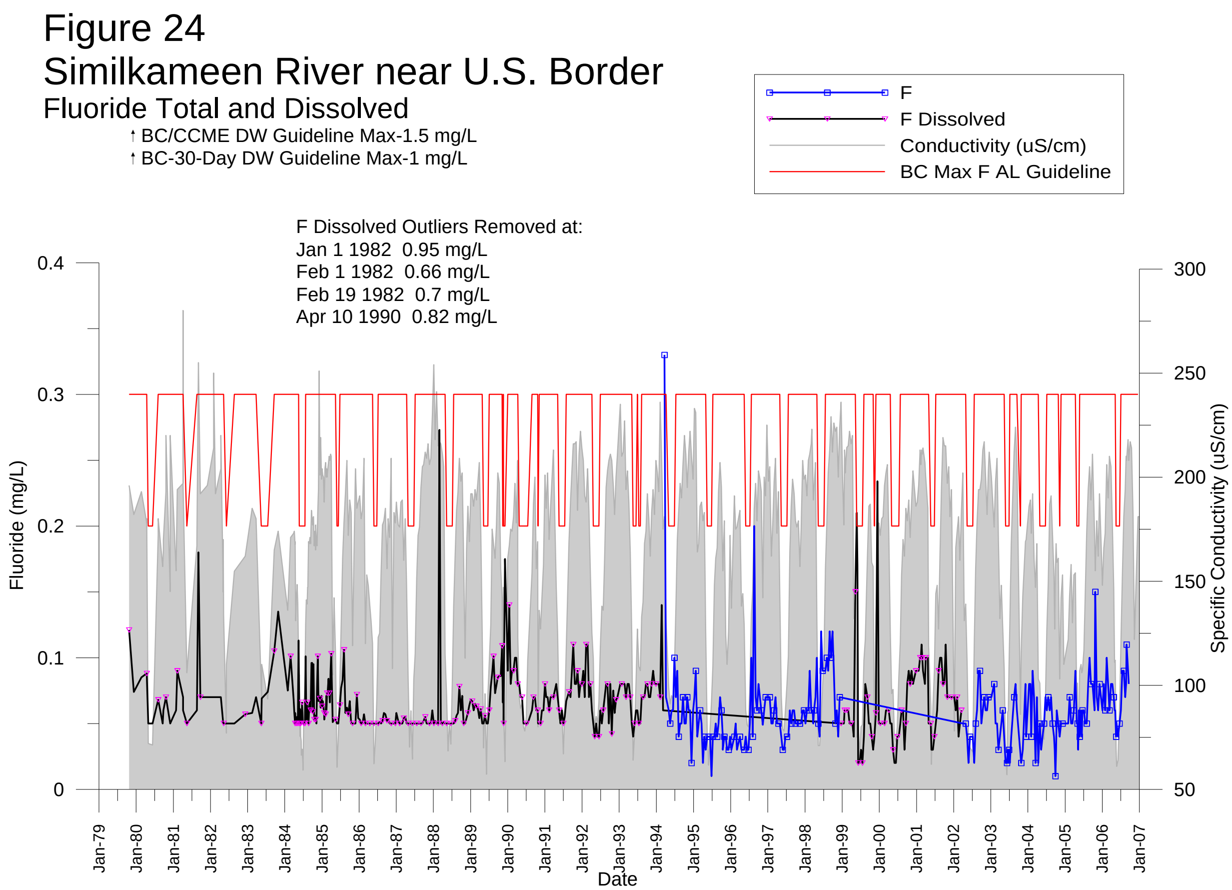


Figure 24
Similkameen River near U.S. Border
Fluoride Total and Dissolved
↑ BC/CCME DW Guideline Max-1.5 mg/L
↑ BC-30-Day DW Guideline Max-1 mg/L
F
F Dissolved
Conductivity (uS/cm)
BC Max F AL Guideline
F Dissolved Outliers Removed at:
Jan 1 1982 0.95 mg/L
Feb 1 1982 0.66 mg/L
Feb 19 1982 0.7 mg/L
Apr 10 1990 0.82 mg/L
Fluoride (mg/L)
Specific Conductivity (uS/cm)
Date
0
0.1
0.2
0.3
0.4
50
100
150
200
250
300
Jan-79
Jan-80
Jan-81
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07

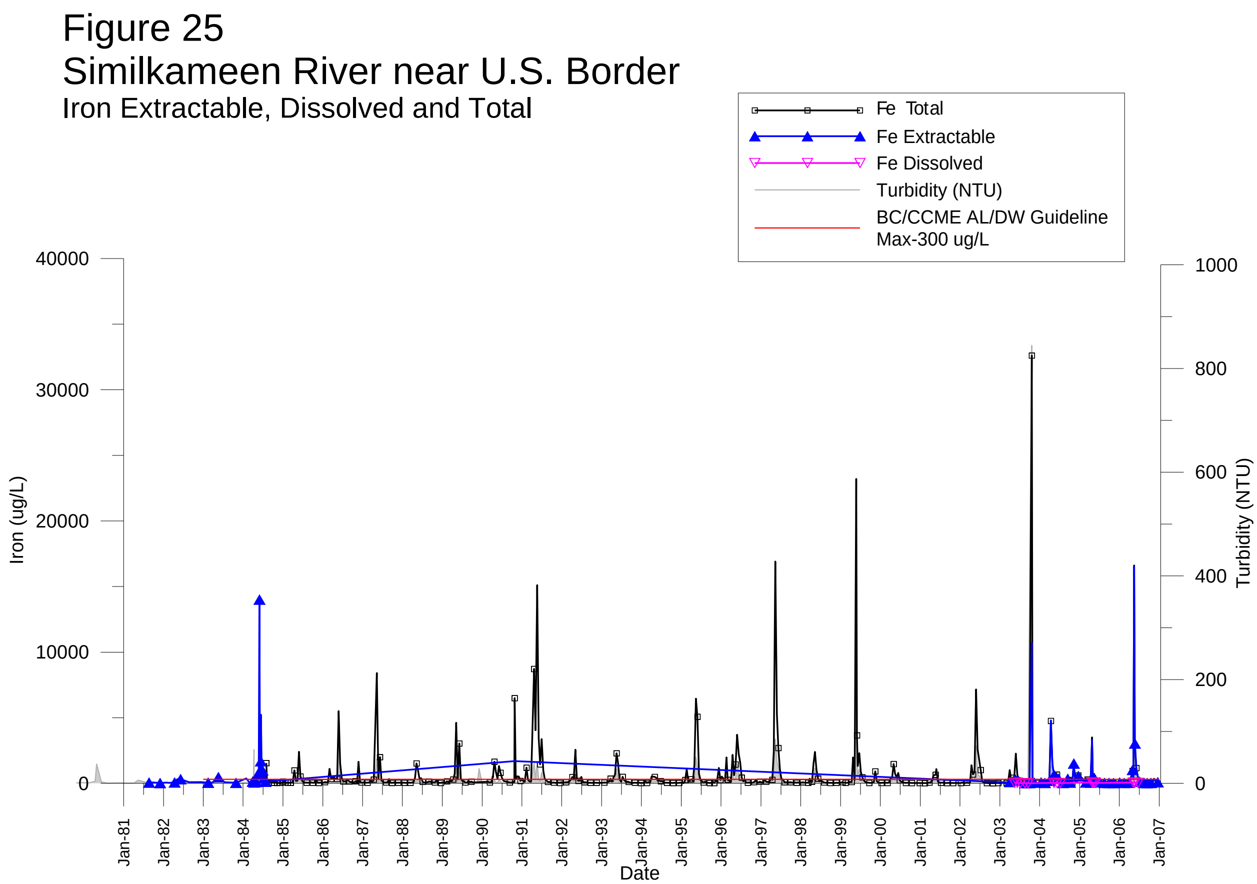


Figure 25
Similkameen River near U.S. Border
Iron Extractable, Dissolved and Total
Fe Total
Fe Extractable
Fe Dissolved
Turbidity (NTU)
BC/CCME AL/DW Guideline
Max-300 ug/L
Iron (ug/L)
Turbidity (NTU)
Date
40000
30000
20000
10000
0
1000
800
600
400
200
0
Jan-81
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07

Figure 26
Similkameen River near U.S. Border
Coliforms Fecal (CFU/100mL)

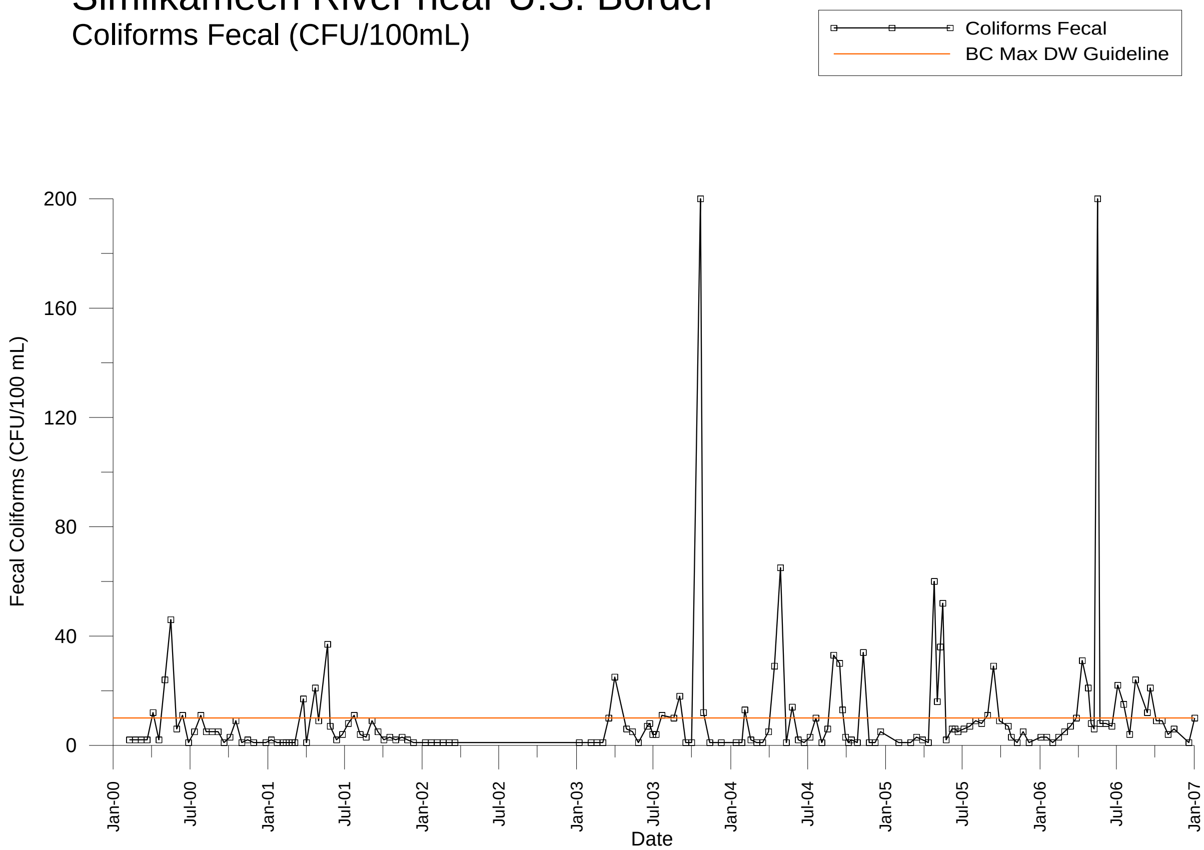


Figure 27
Similkameen River near U.S. Border
Gallium Extractable, Dissolved and Total

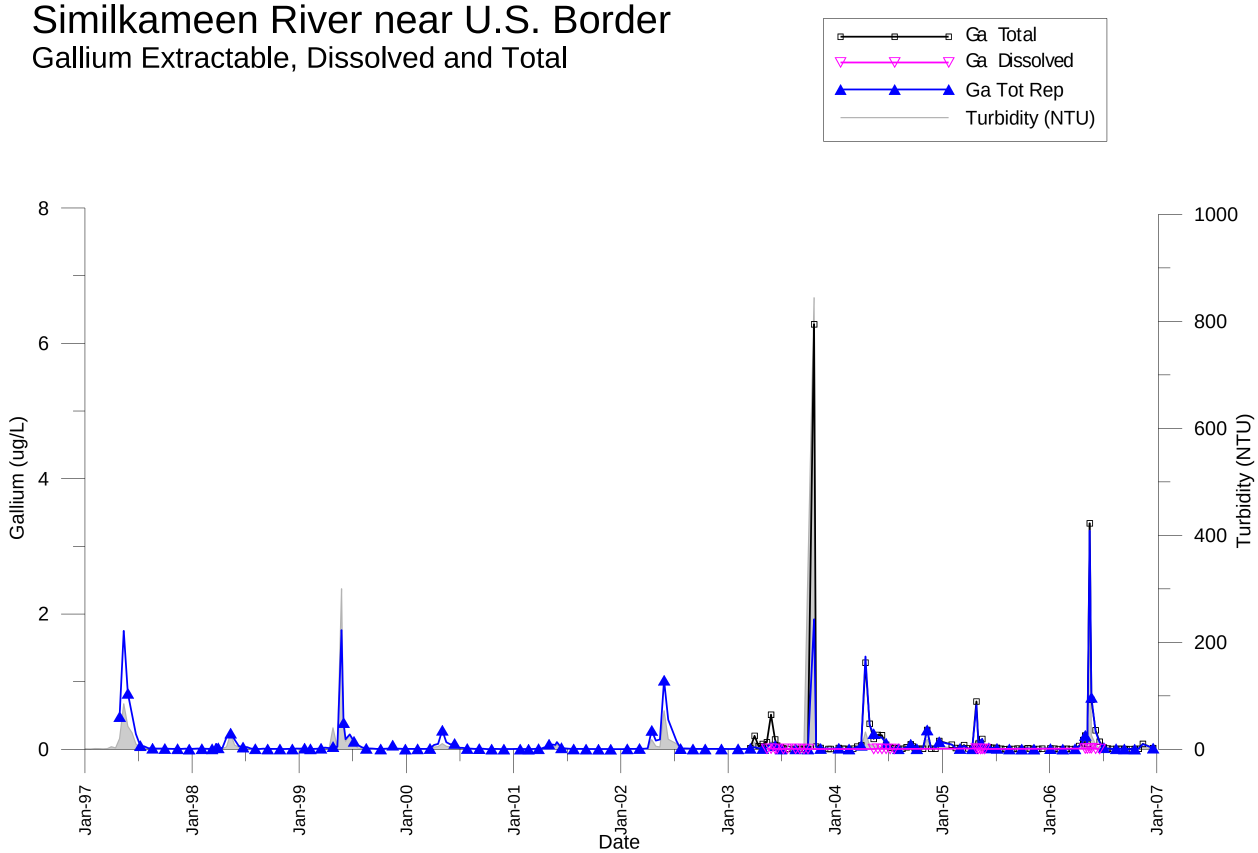


Figure 28
Similkameen River near U.S. Border
Hardness Total

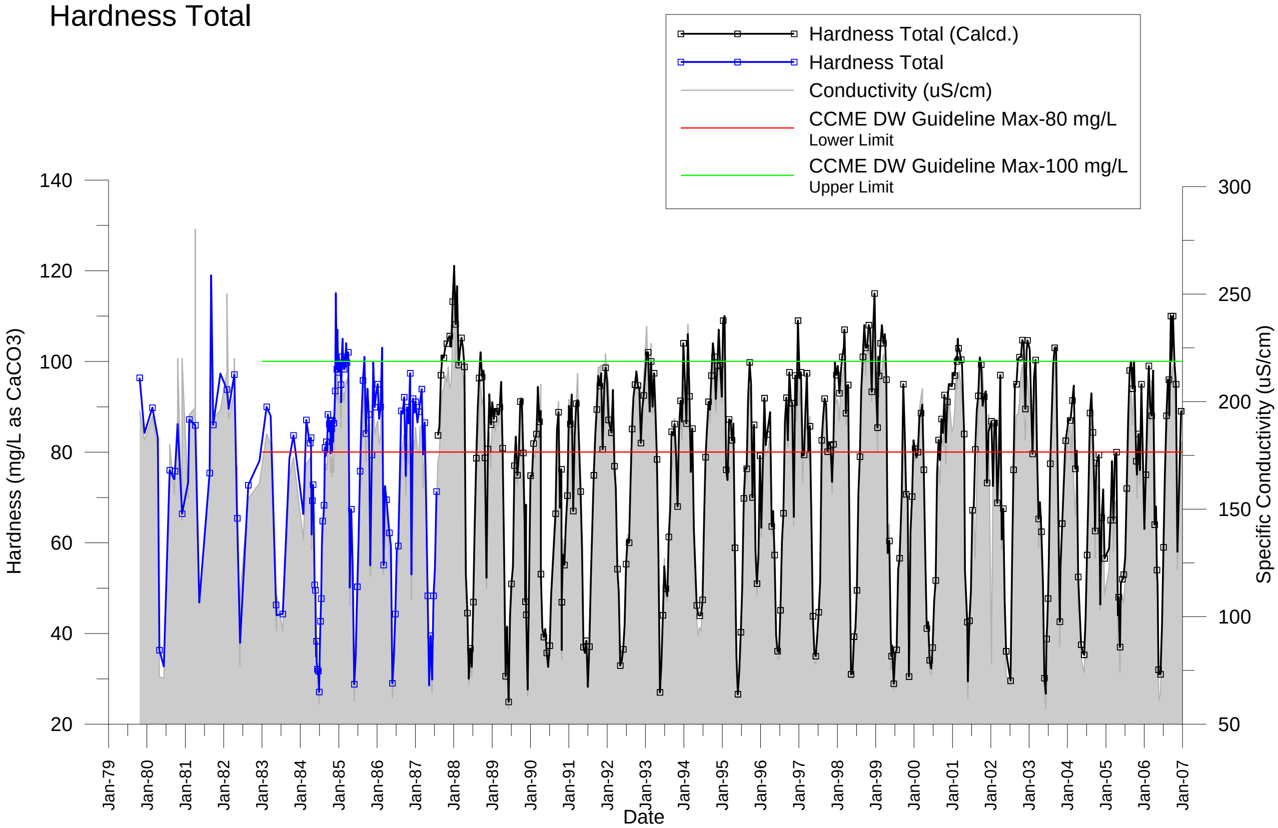


Figure 29
Similkameen River near U.S. Border
Potassium Dissolved and Extractable

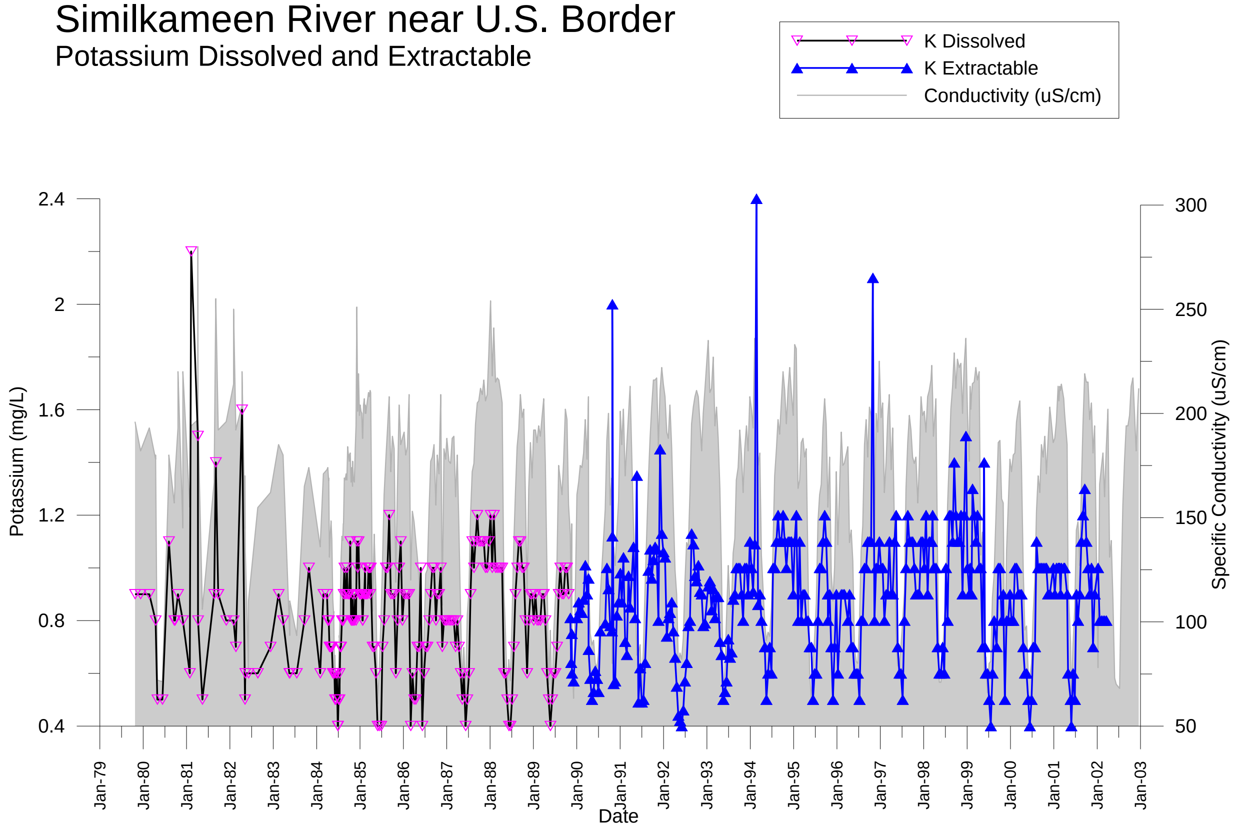
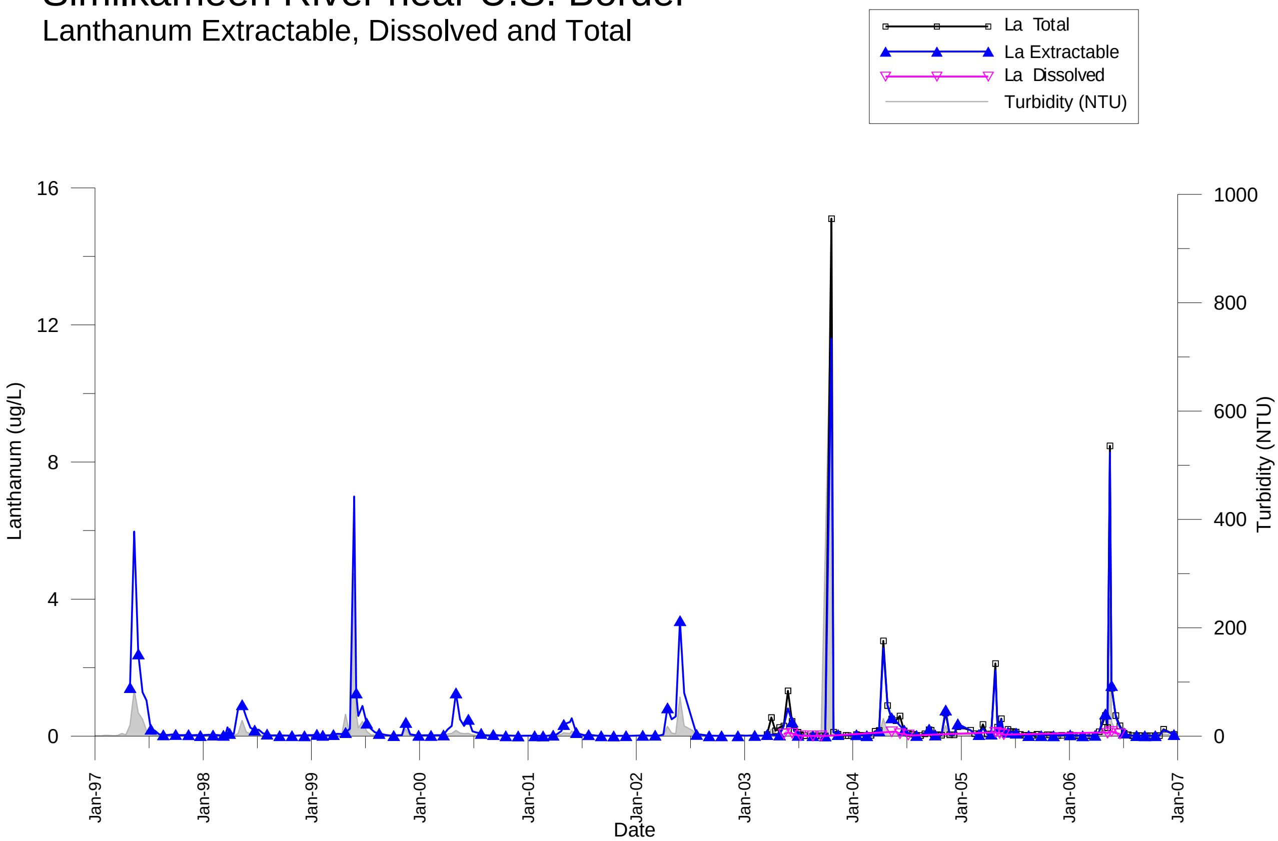


Figure 30
Similkameen River near U.S. Border
Lanthanum Extractable, Dissolved and Total



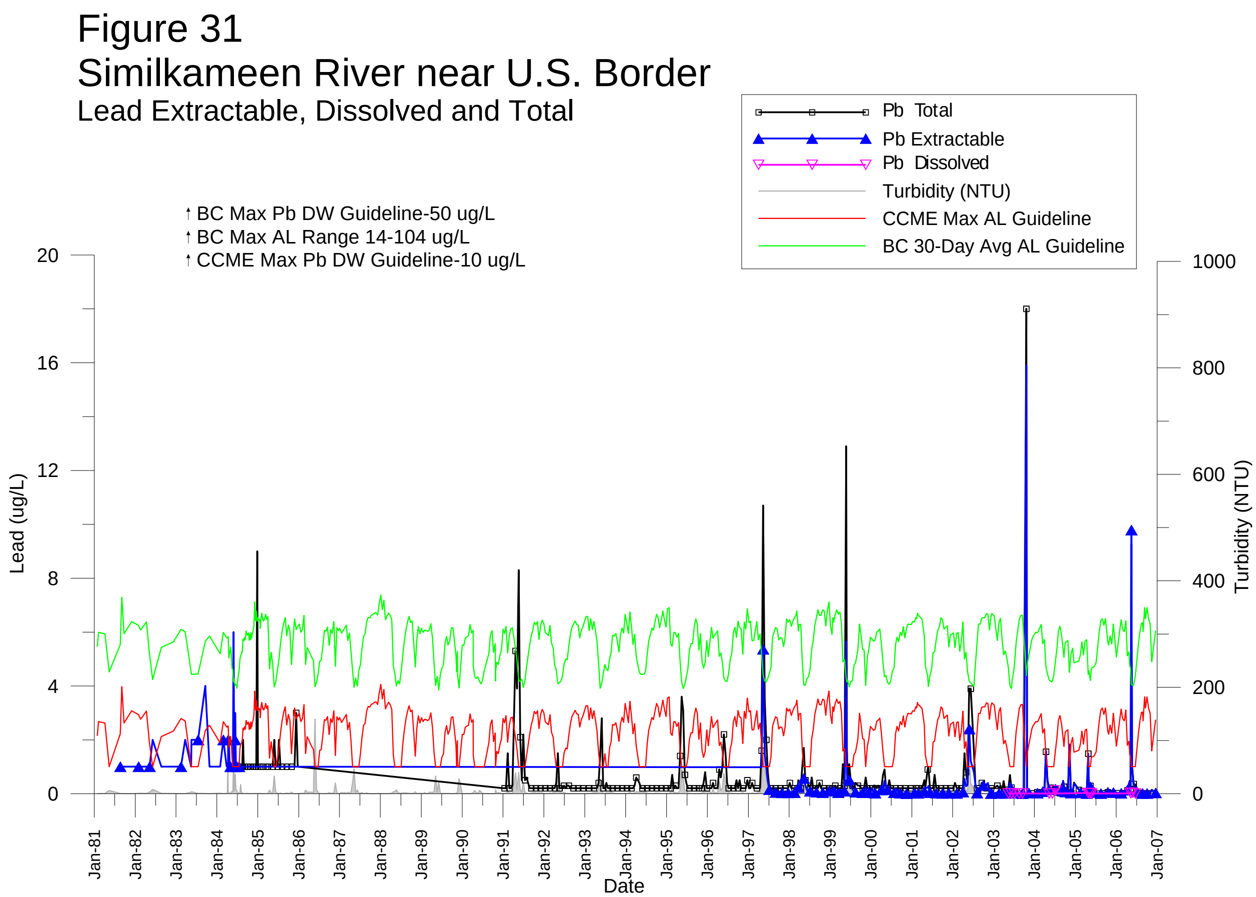


Figure 31
Similkameen River near U.S. Border
Lead Extractable, Dissolved and Total
Pb Total
Pb Extractable
Pb Dissolved
Turbidity (NTU)
CCME Max AL Guideline
BC 30-Day Avg AL Guideline
↑ BC Max Pb DW Guideline-50 ug/L
↑ BC Max AL Range 14-104 ug/L
↑ CCME Max Pb DW Guideline-10 ug/L
Lead (ug/L)
Turbidity (NTU)
Date
0
4
8
12
16
20
200
400
600
800
1000
Jan-81
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07

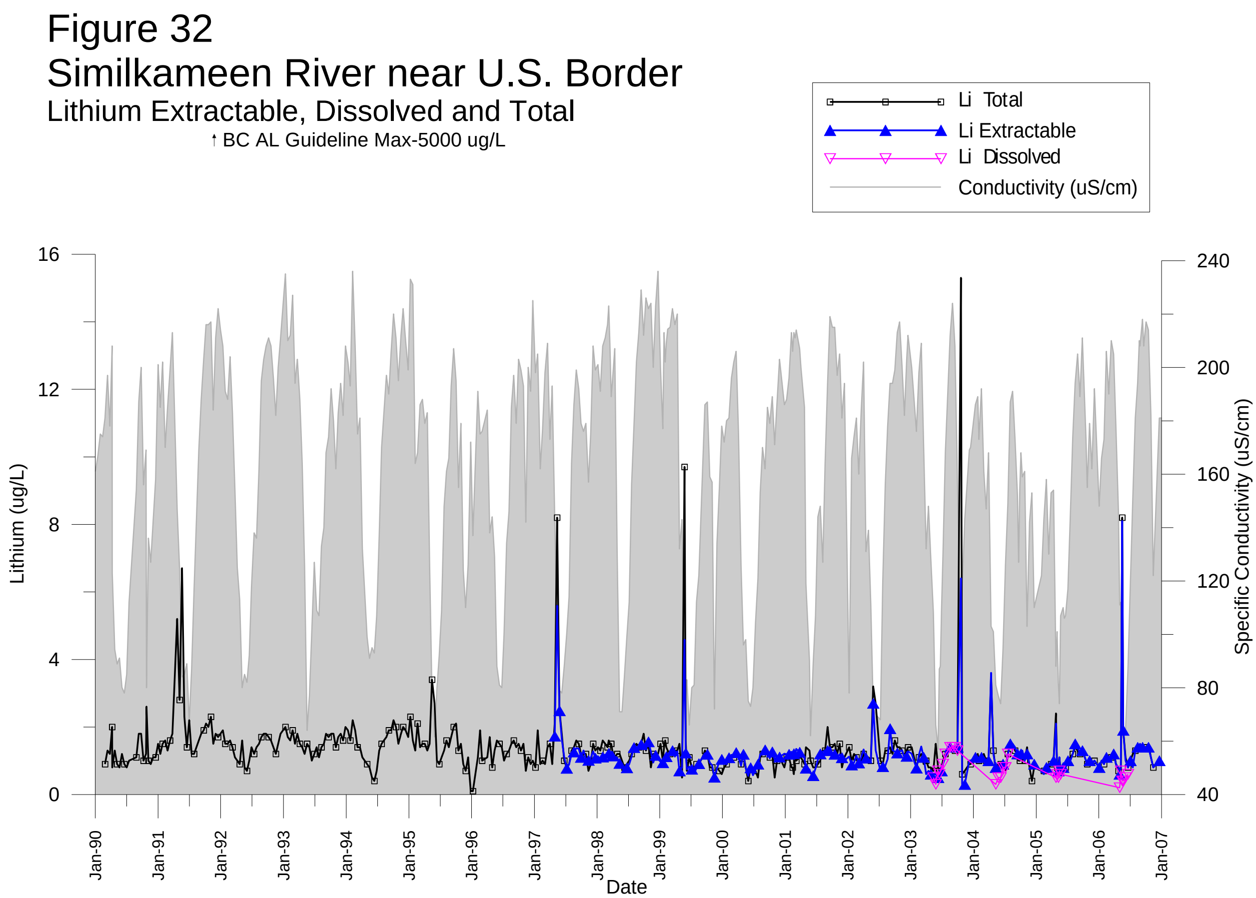


Figure 32
Similkameen River near U.S. Border
Lithium Extractable, Dissolved and Total
↑ BC AL Guideline Max-5000 ug/L
Li Total
Li Extractable
Li Dissolved
Conductivity (uS/cm)
Lithium (ug/L)
Specific Conductivity (uS/cm)
Date
0
4
8
12
16
40
80
120
160
200
240
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07

Figure 33
Similkameen River near U.S. Border
Magnesium Dissolved (Calcd.), Dissolved and Extractable

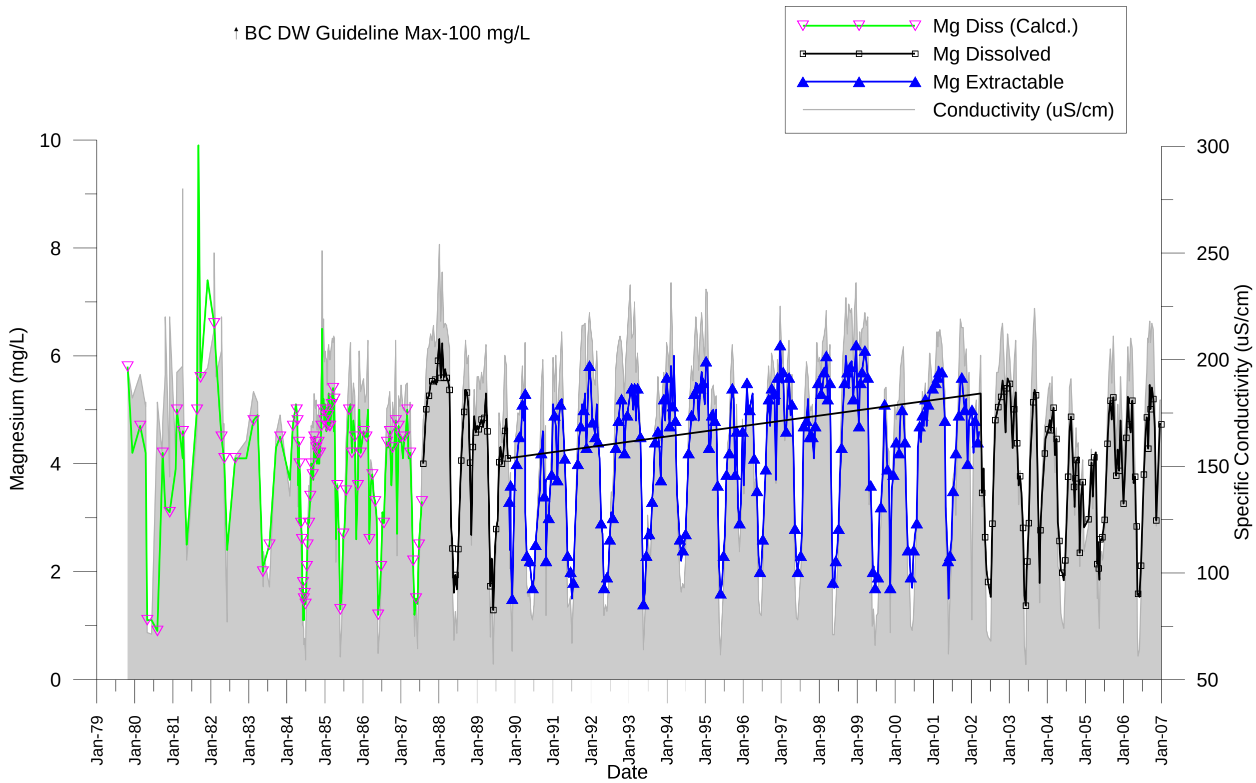
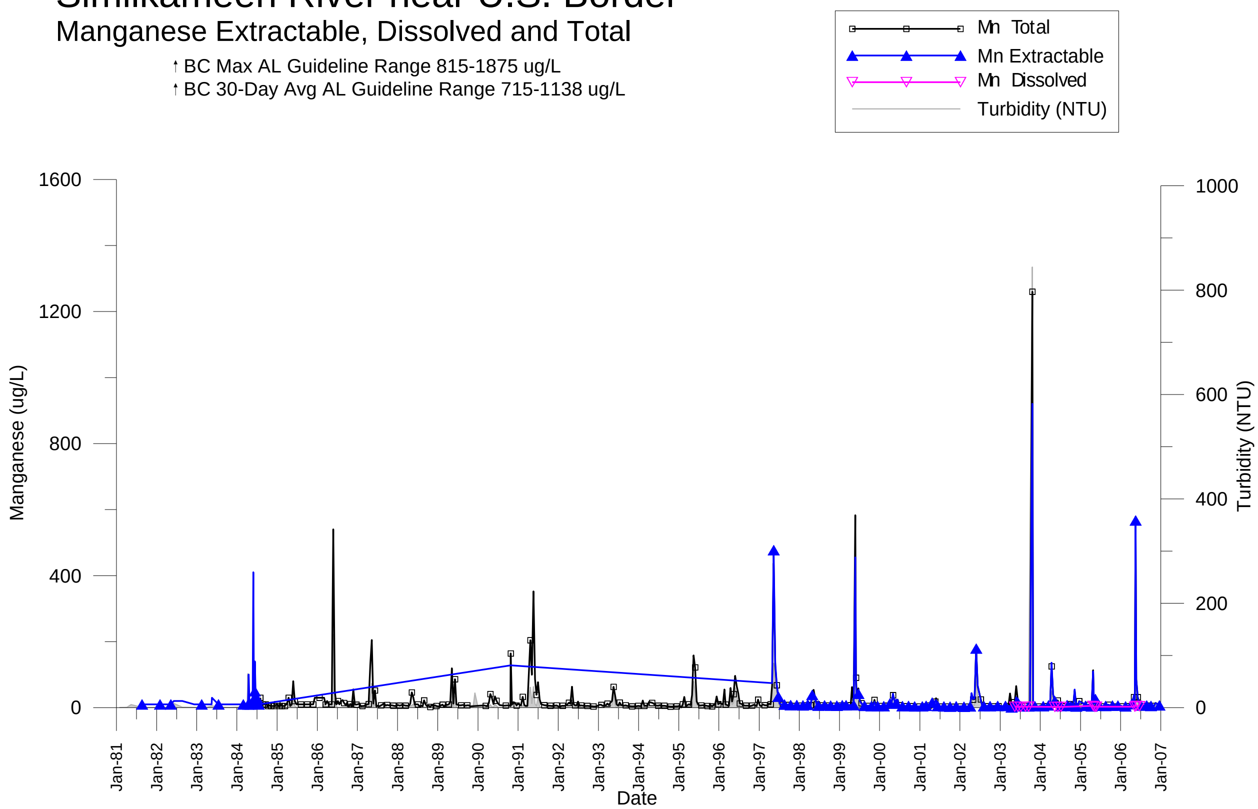


Figure 34
Similkameen River near U.S. Border
Manganese Extractable, Dissolved and Total



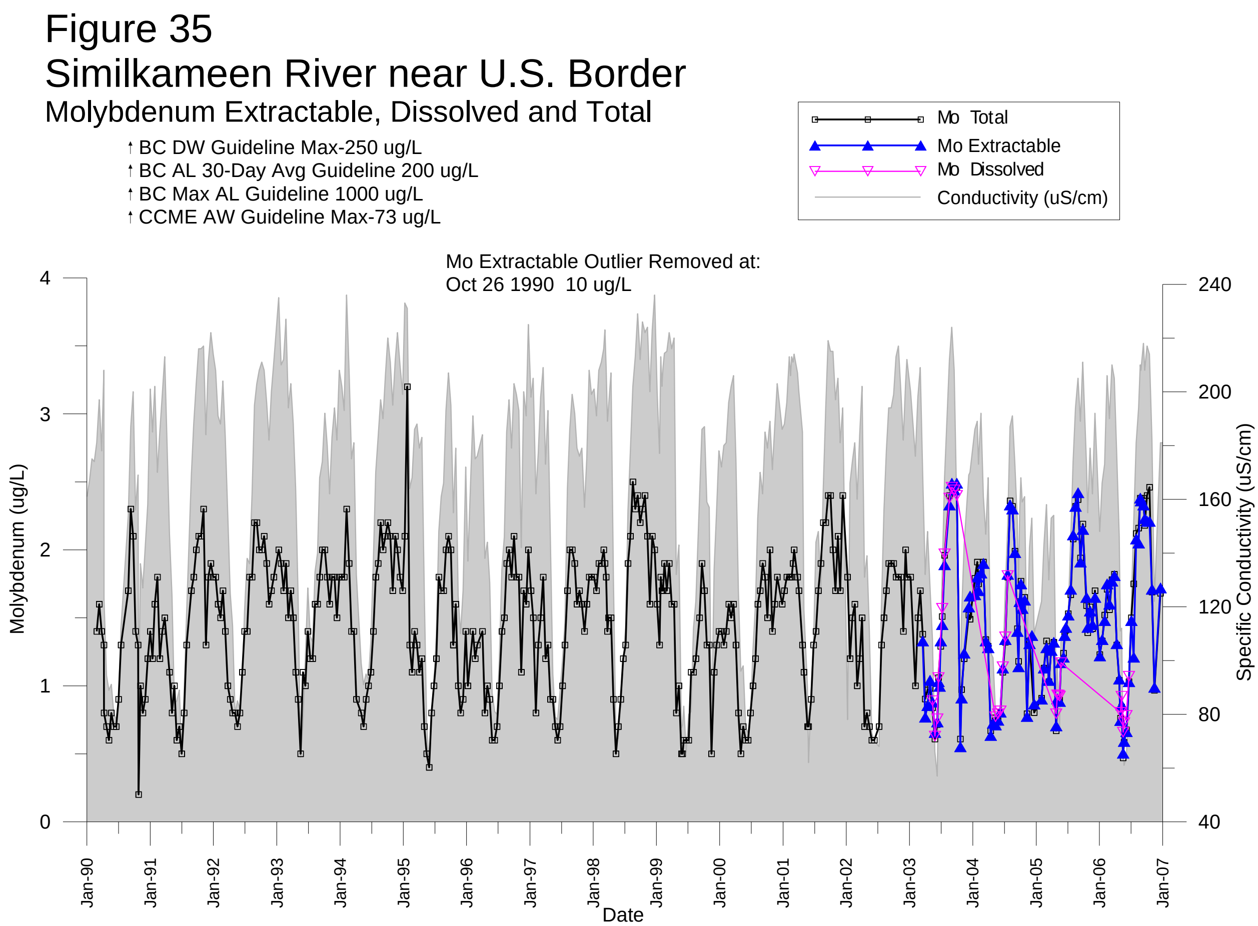


Figure 35
Similkameen River near U.S. Border
Molybdenum Extractable, Dissolved and Total
↑ BC DW Guideline Max-250 ug/L
↑ BC AL 30-Day Avg Guideline 200 ug/L
↑ BC Max AL Guideline 1000 ug/L
↑ CCME AW Guideline Max-73 ug/L
Mo Total
Mo Extractable
Mo Dissolved
Conductivity (uS/cm)
Mo Extractable Outlier Removed at:
Oct 26 1990 10 ug/L
Molybdenum (ug/L)
Specific Conductivity (uS/cm)
Date
0
1
2
3
4
40
80
120
160
200
240
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07

Figure 36
Similkameen River near U.S. Border
Nitrogen Dissolved Nitrate

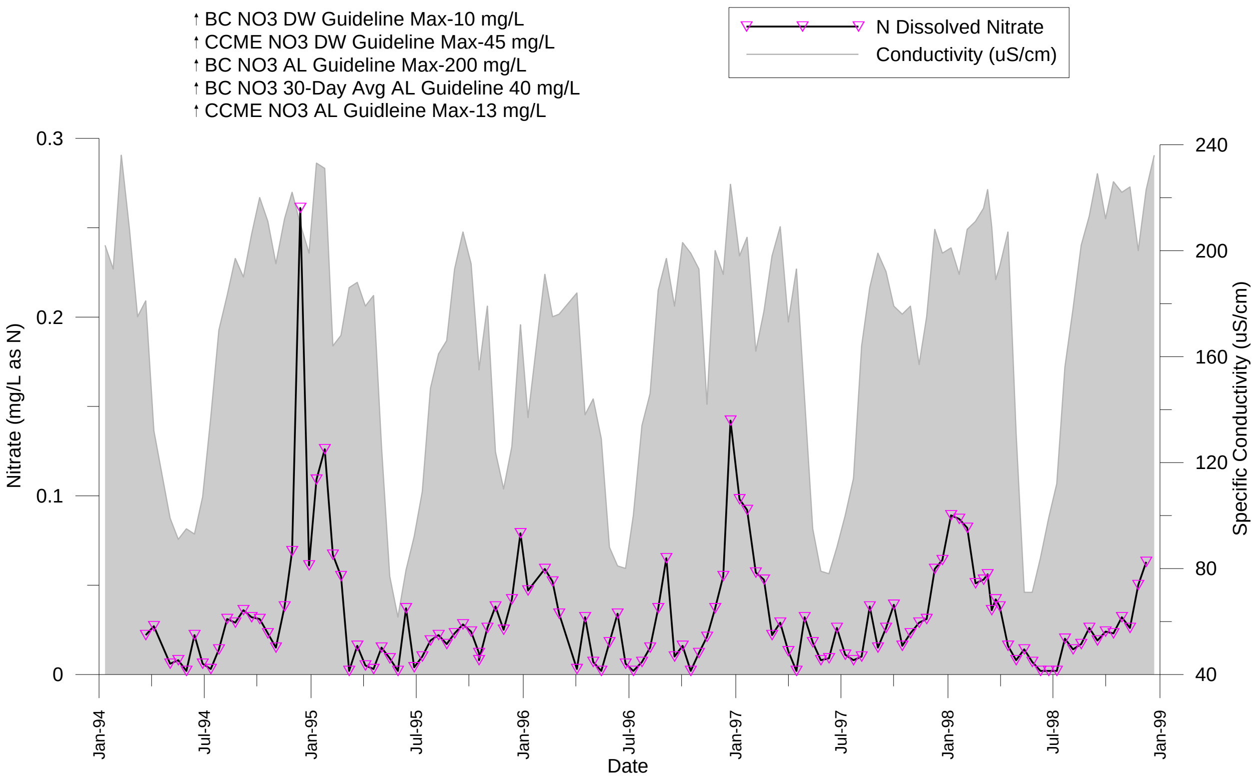


Figure 37
Similkameen River near U.S. Border
Nitrogen Nitrate + Nitrite

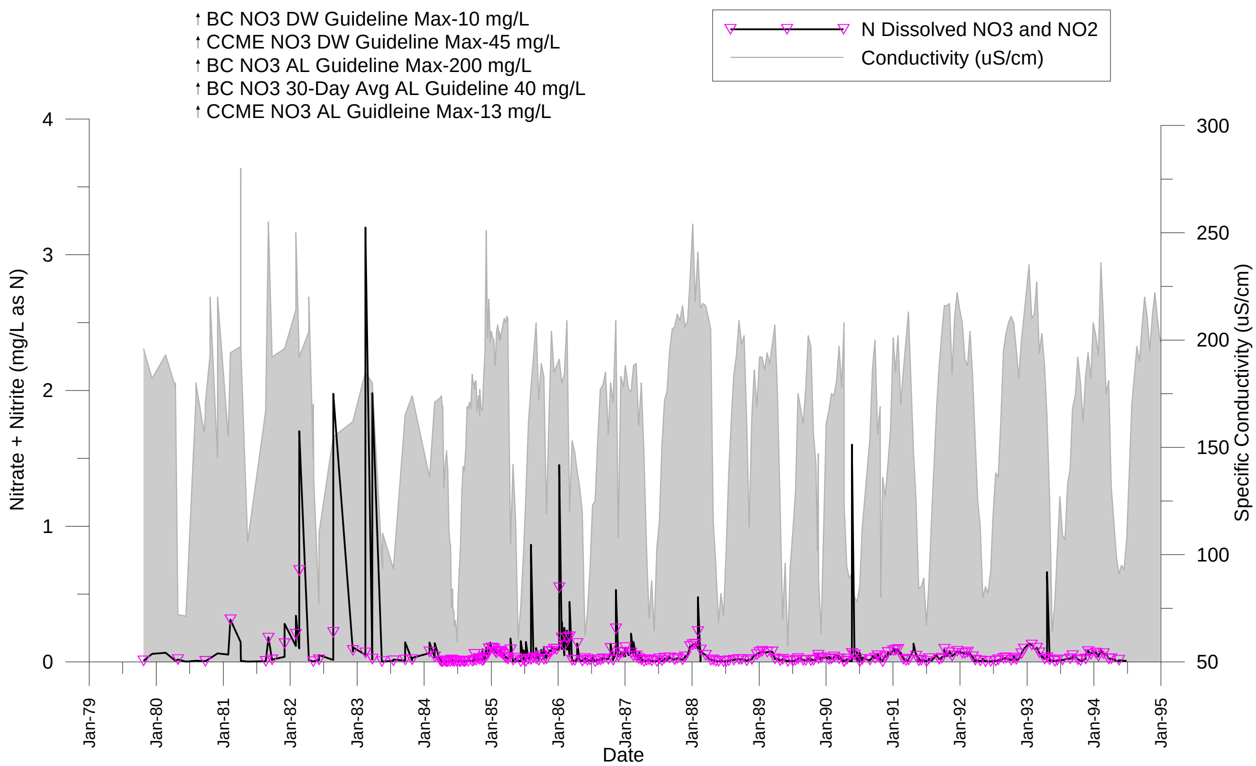


Figure 38
Similkameen River near U.S. Border
Nitrogen Nitrite

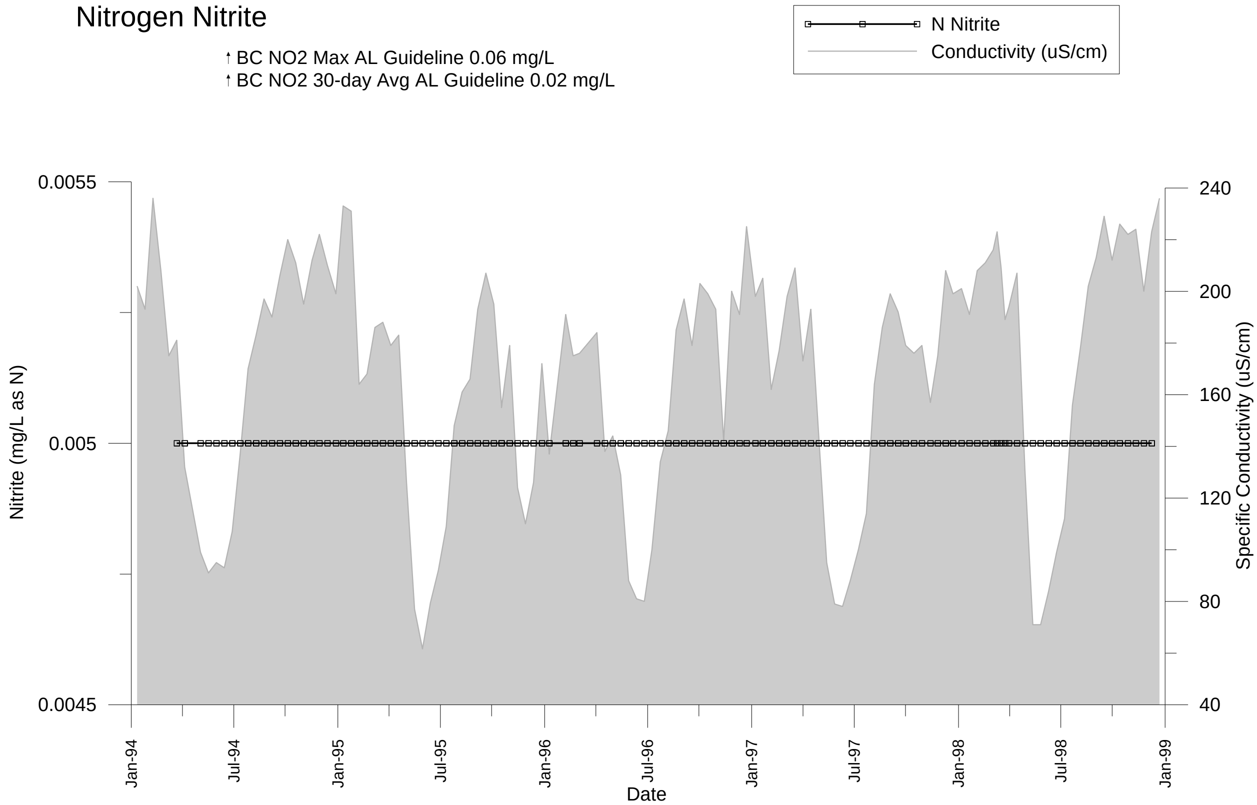


Figure 39
Similkameen River near U.S. Border
Nitrogen Total Dissolved

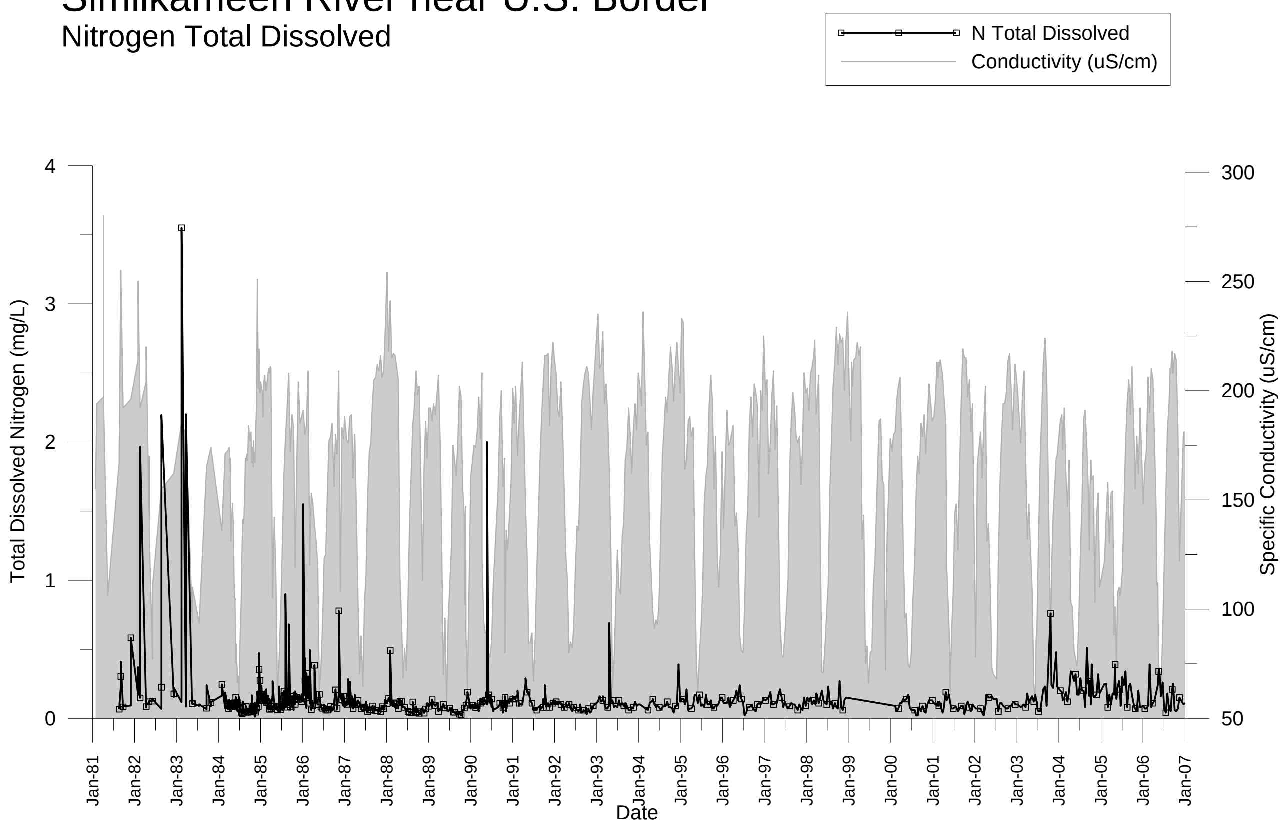


Figure 40
Similkameen River near U.S. Border
Sodium Dissolved and Extractable

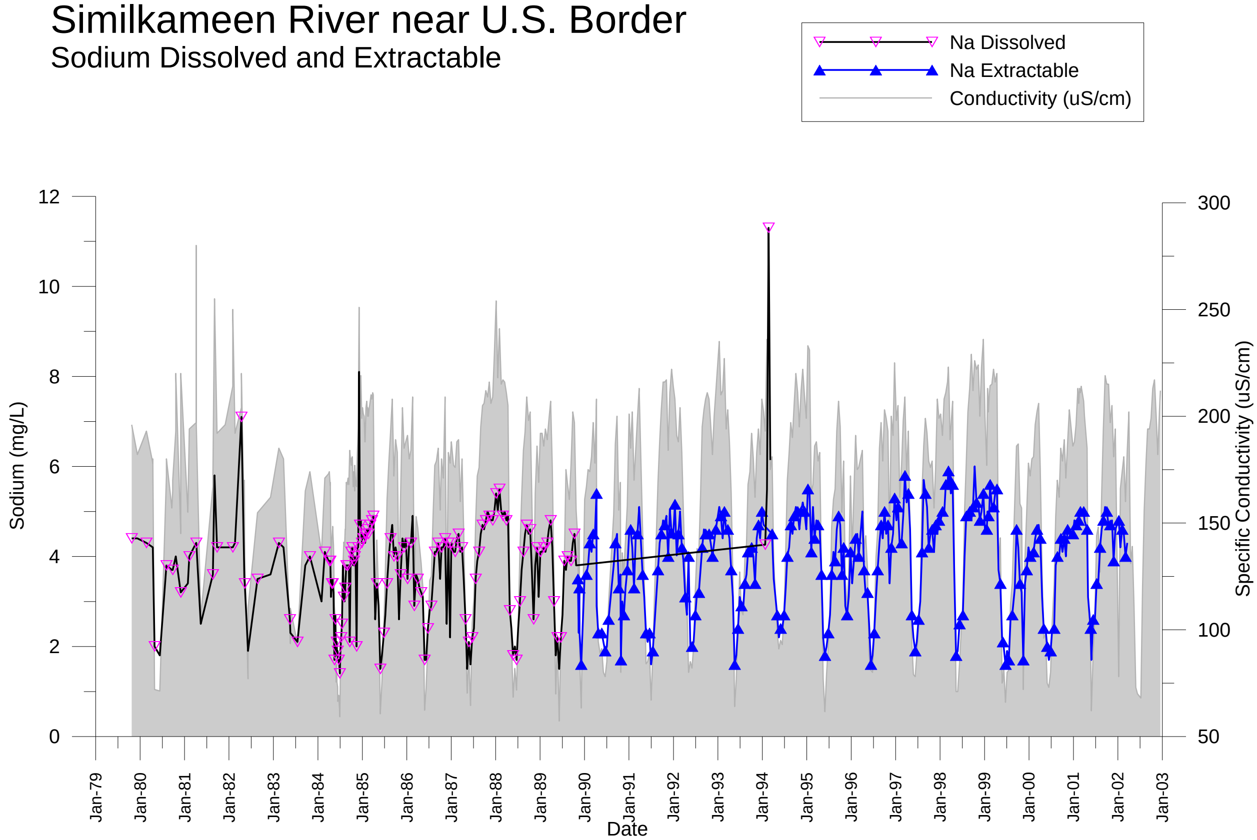
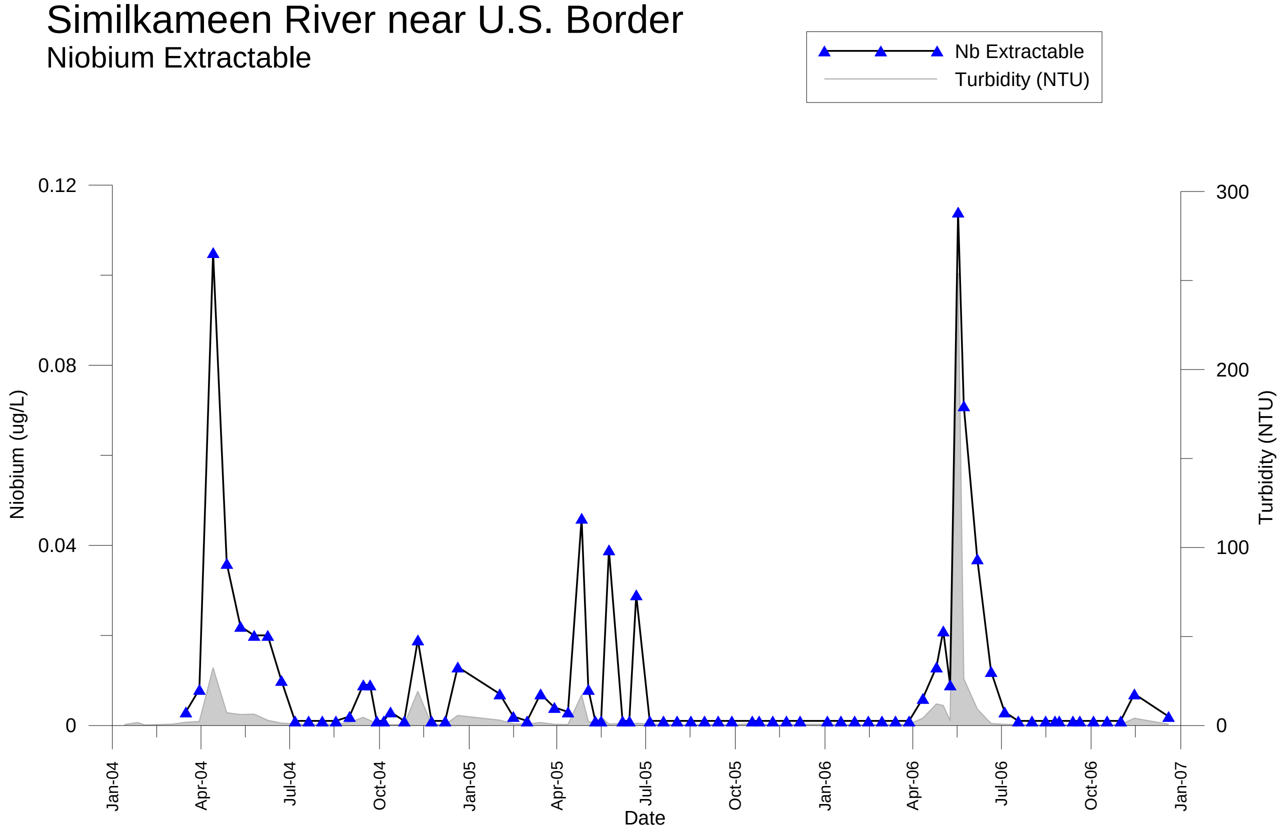


Figure 41
Similkameen River near U.S. Border
Niobium Extractable



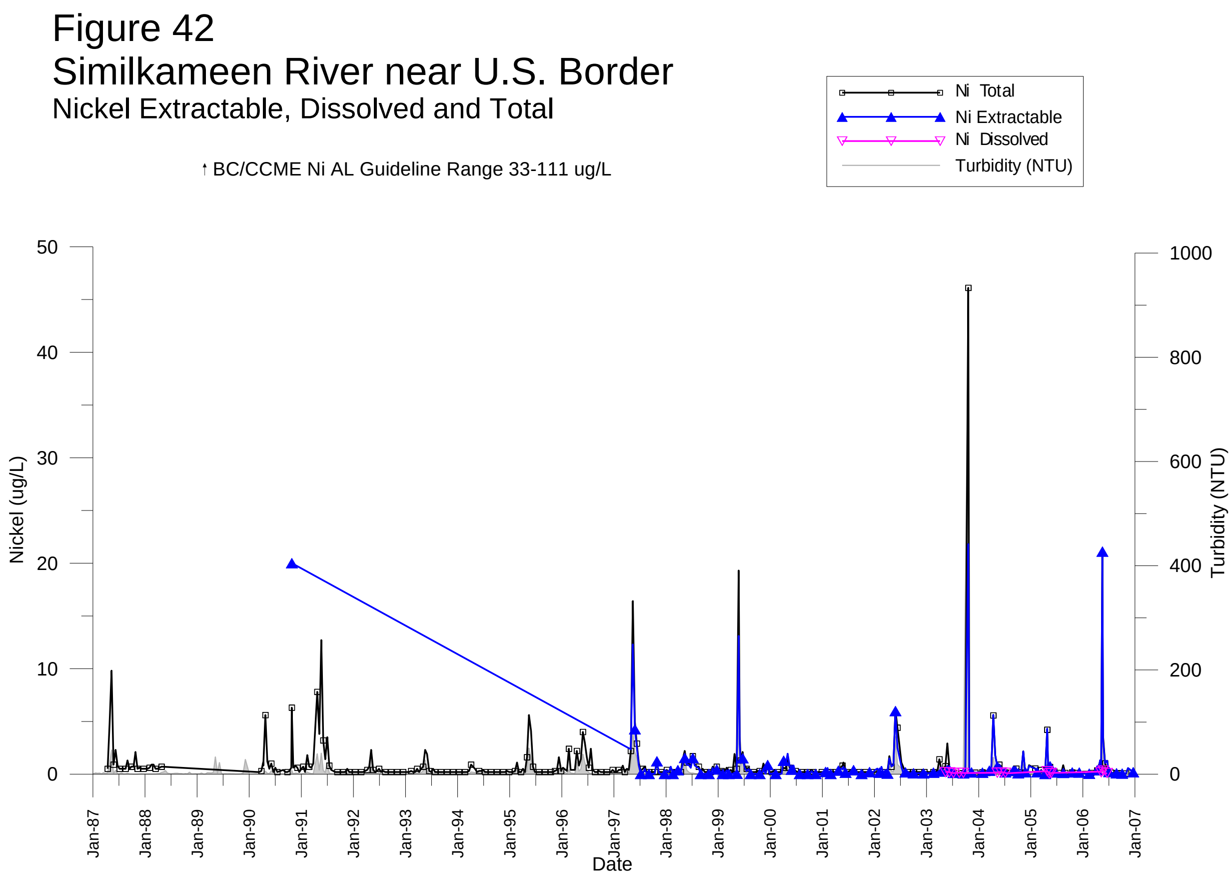


Figure 42
Similkameen River near U.S. Border
Nickel Extractable, Dissolved and Total
↑ BC/CCME Ni AL Guideline Range 33-111 ug/L
Ni Total
Ni Extractable
Ni Dissolved
Turbidity (NTU)
Nickel (ug/L)
Turbidity (NTU)
Date
0
10
20
30
40
50
0
200
400
600
800
1000
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07

Figure 43
Similkameen River near U.S. Border
Phosphate Dissolved Ortho

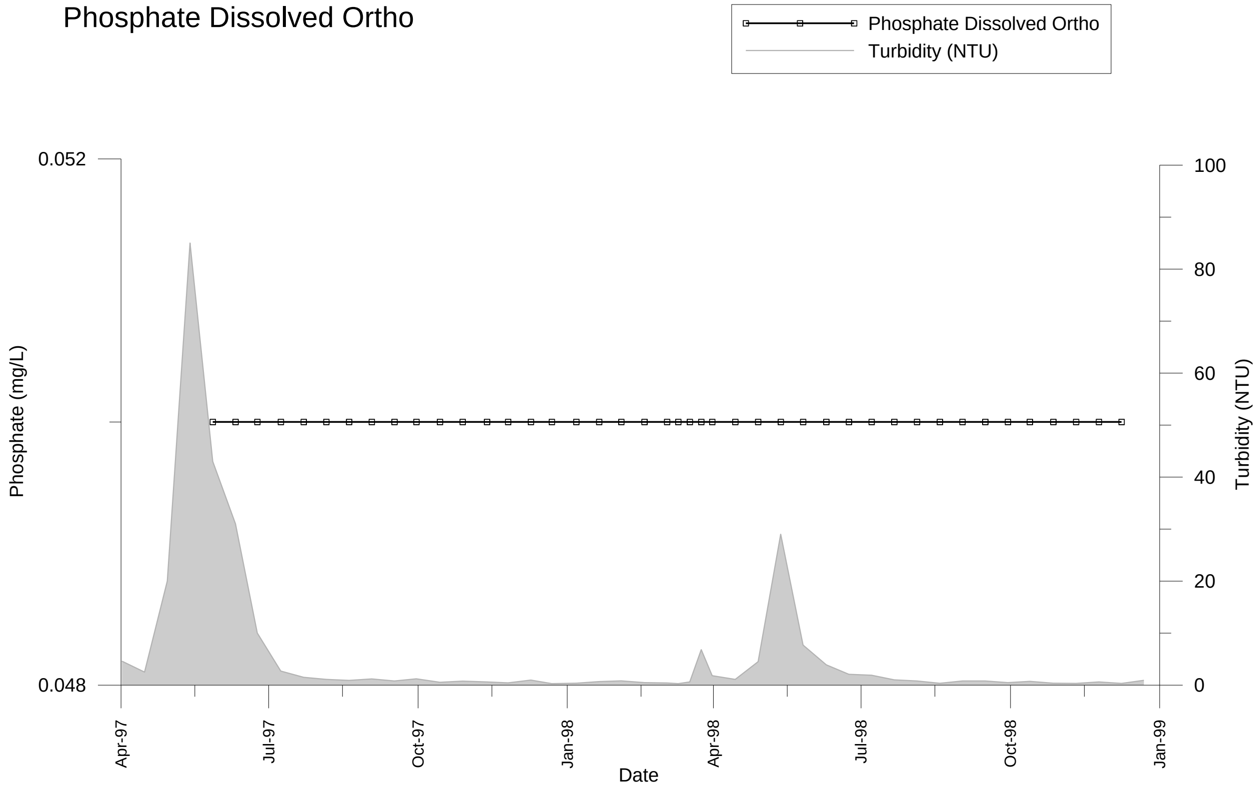
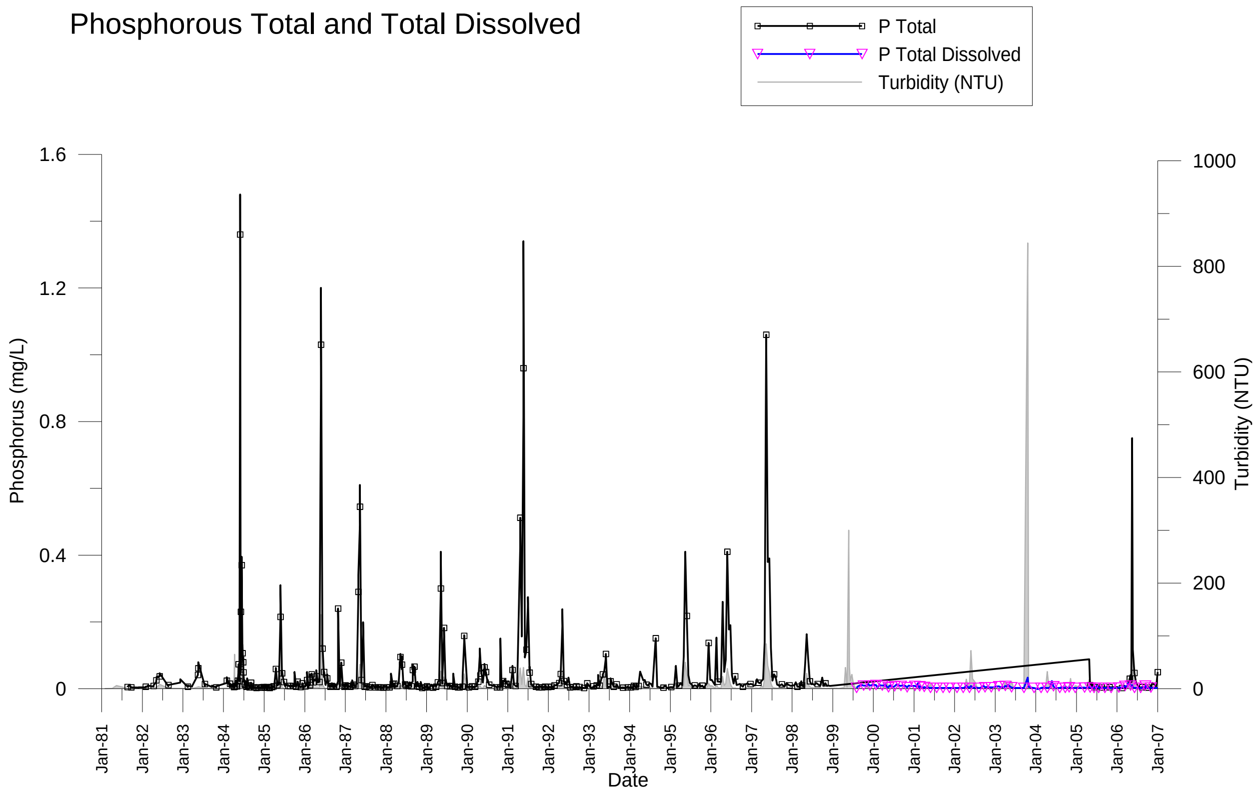


Figure 44
Similkameen River near U.S. Border
Phosphorous Total and Total Dissolved



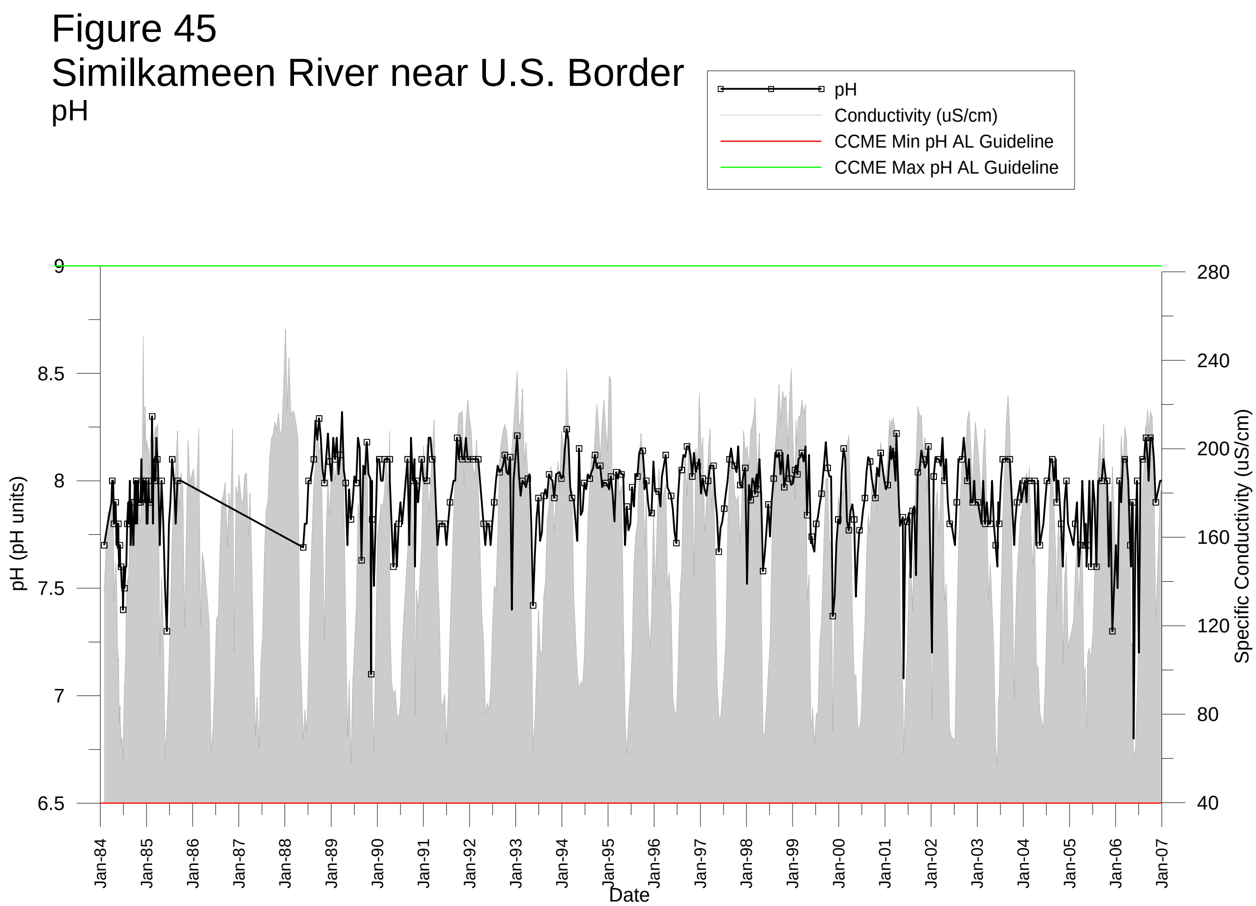


Figure 45
Similkameen River near U.S. Border
pH
pH
Conductivity (uS/cm)
CCME Min pH AL Guideline
CCME Max pH AL Guideline
pH (pH units)
Specific Conductivity (uS/cm)
Date
9
8.5
8
7.5
7
6.5
280
240
200
160
120
80
40
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07

Figure 46
Similkameen River near U.S. Border
Rubudium Extractable, Dissolved and Total

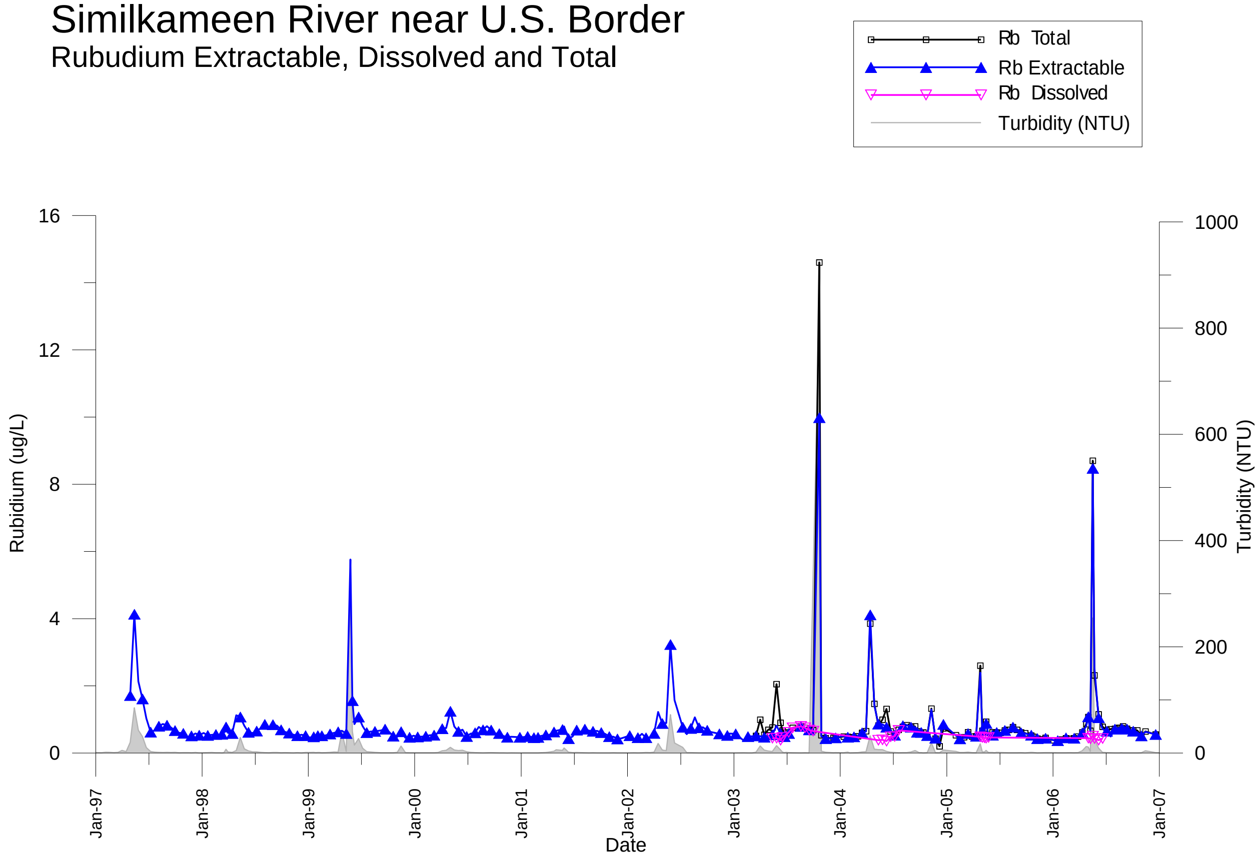
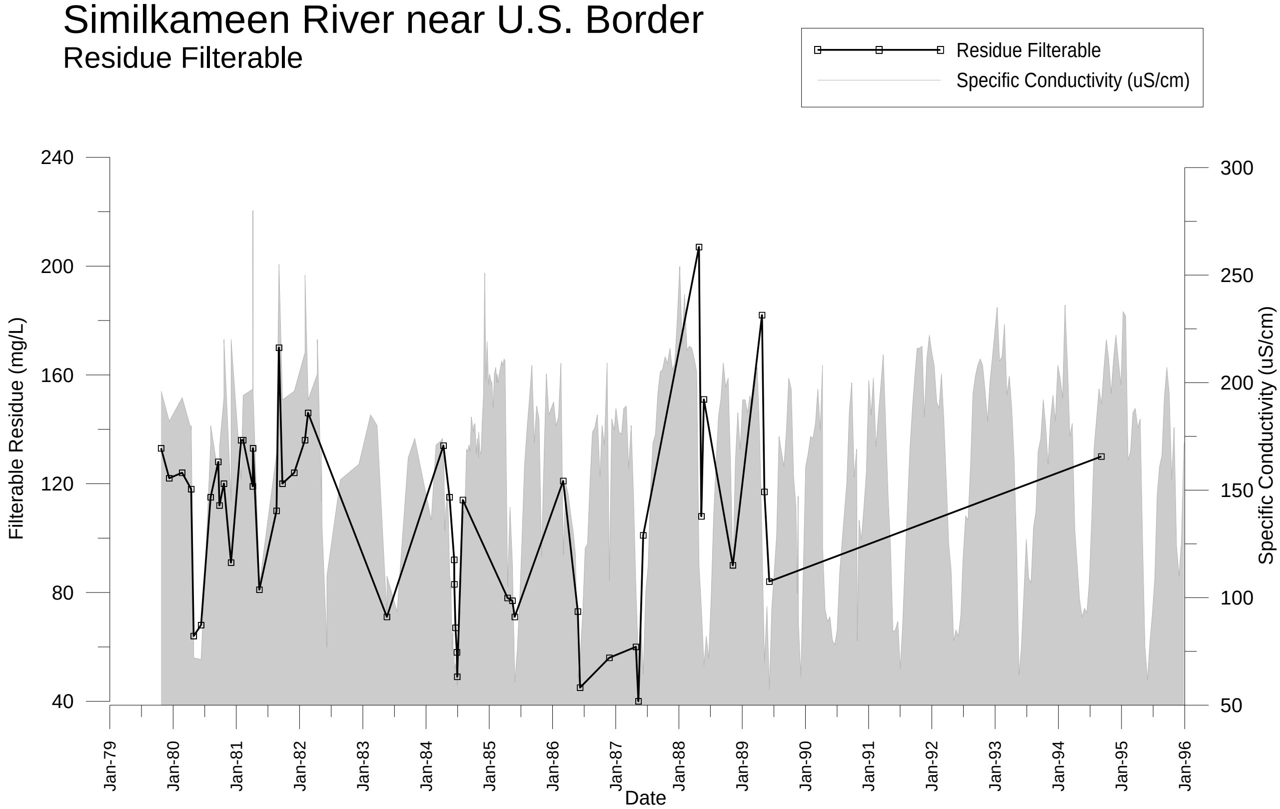


Figure 47
Similkameen River near U.S. Border
Residue Filterable



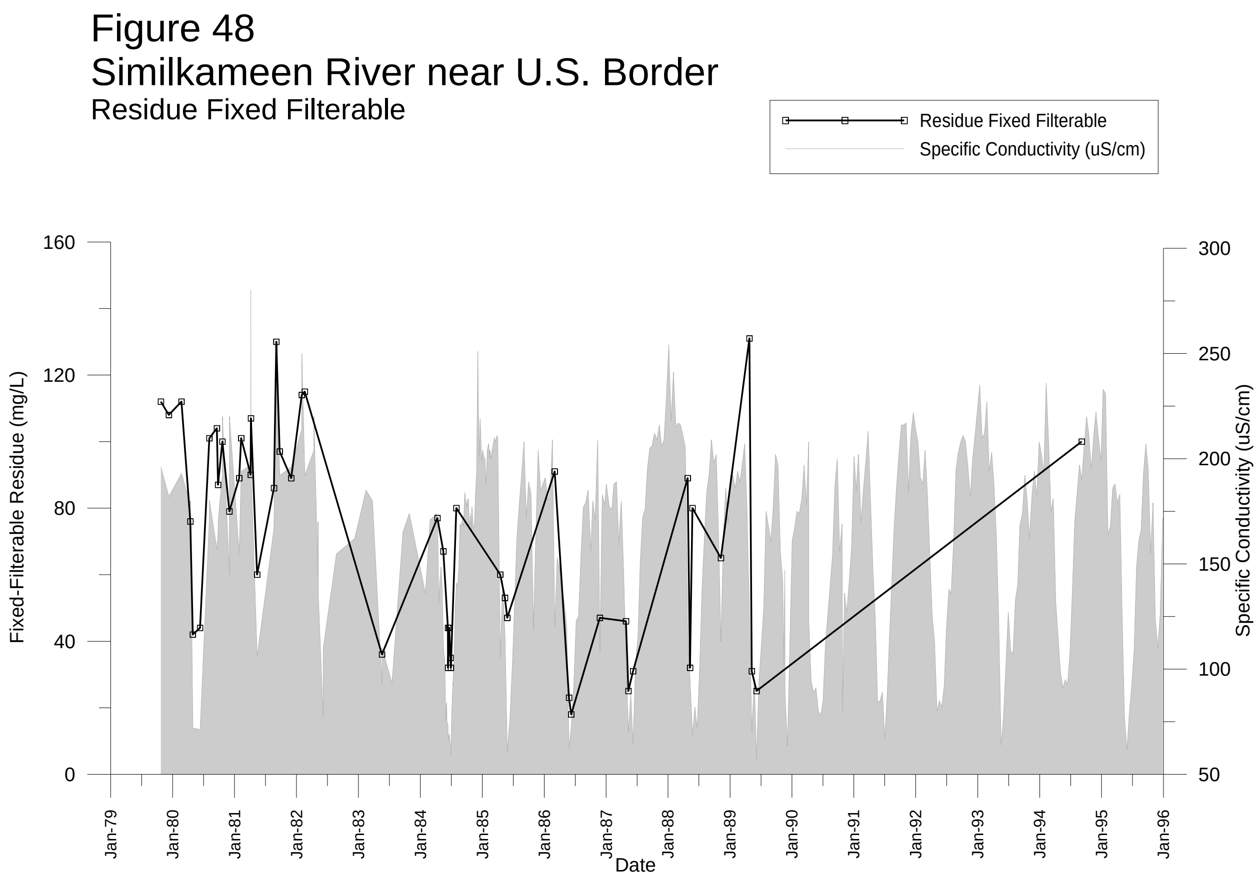


Figure 48
Similkameen River near U.S. Border
Residue Fixed Filterable
Residue Fixed Filterable
Specific Conductivity (uS/cm)
Fixed-Filterable Residue (mg/L)
Specific Conductivity (uS/cm)
Date
0
40
80
120
160
50
100
150
200
250
300
Jan-79
Jan-80
Jan-81
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96

Figure 49
Similkameen River near U.S. Border
Residue Fixed Non-filterable

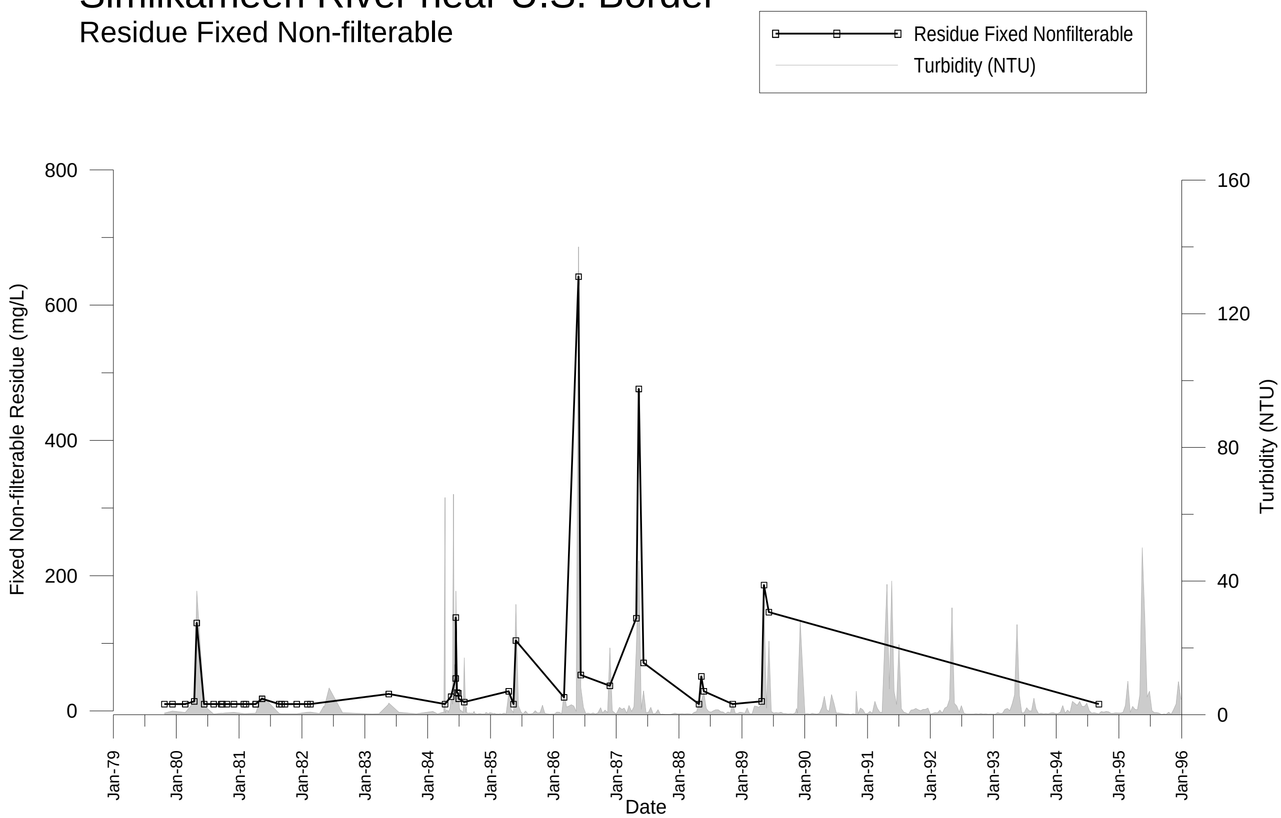


Figure 50
Similkameen River near U.S. Border
Residue Non-filterable

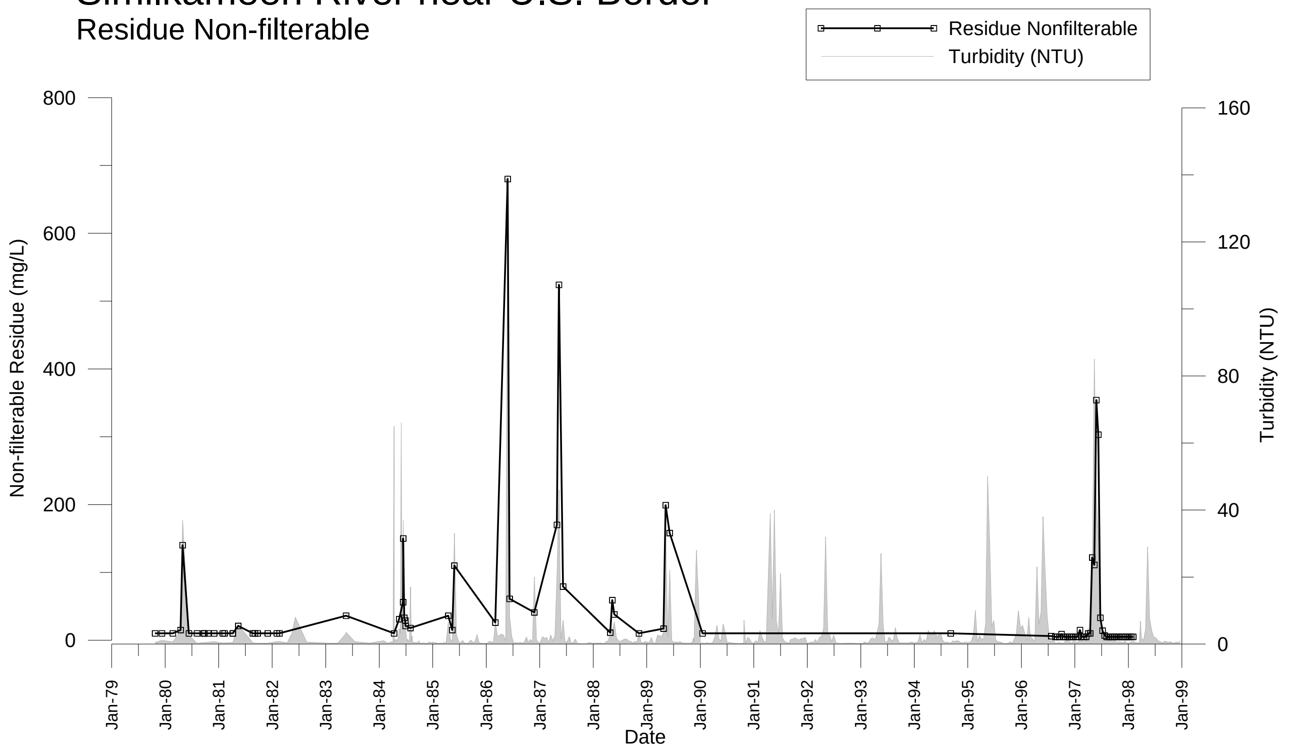


Figure 51
Similkameen River near U.S. Border
Selenium Extractable, Dissolved and Total

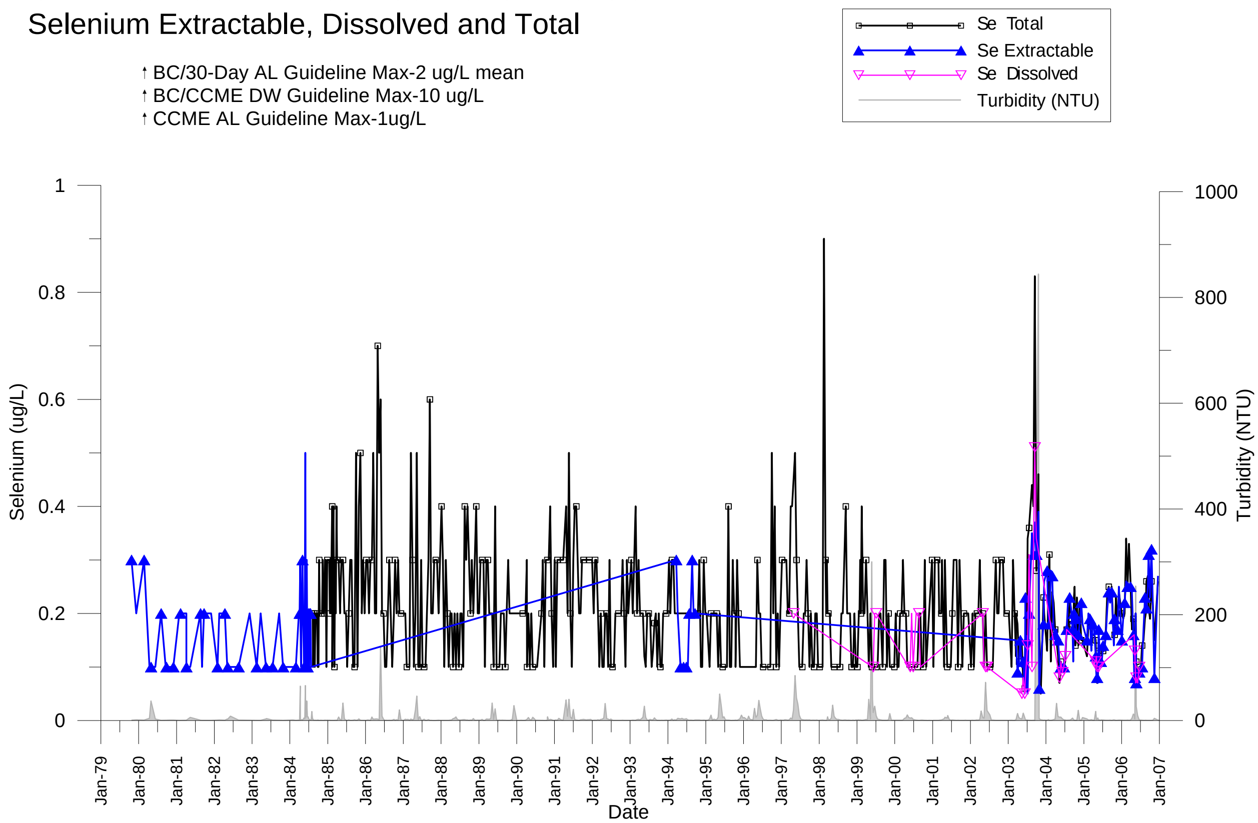


Figure 52
Similkameen River near U.S. Border
Silicon Extractable

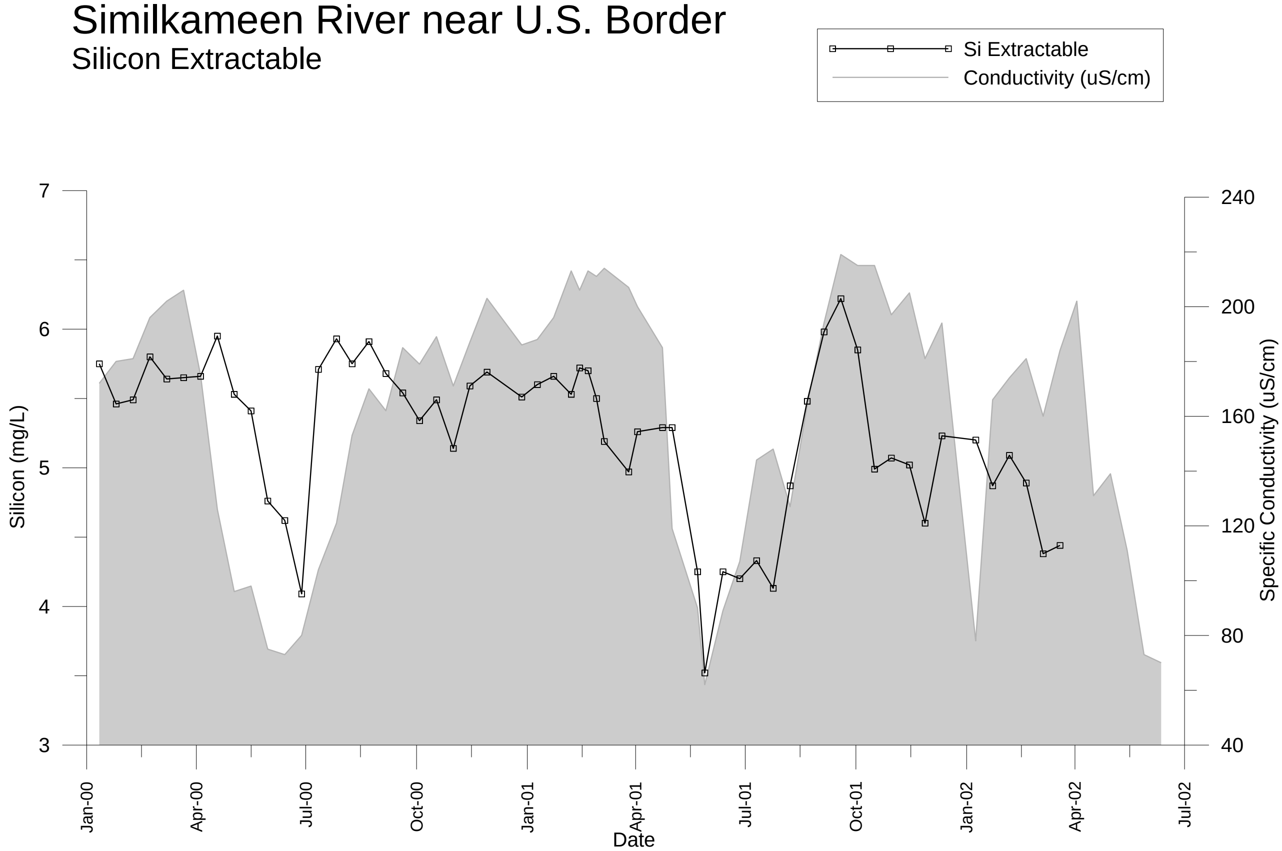
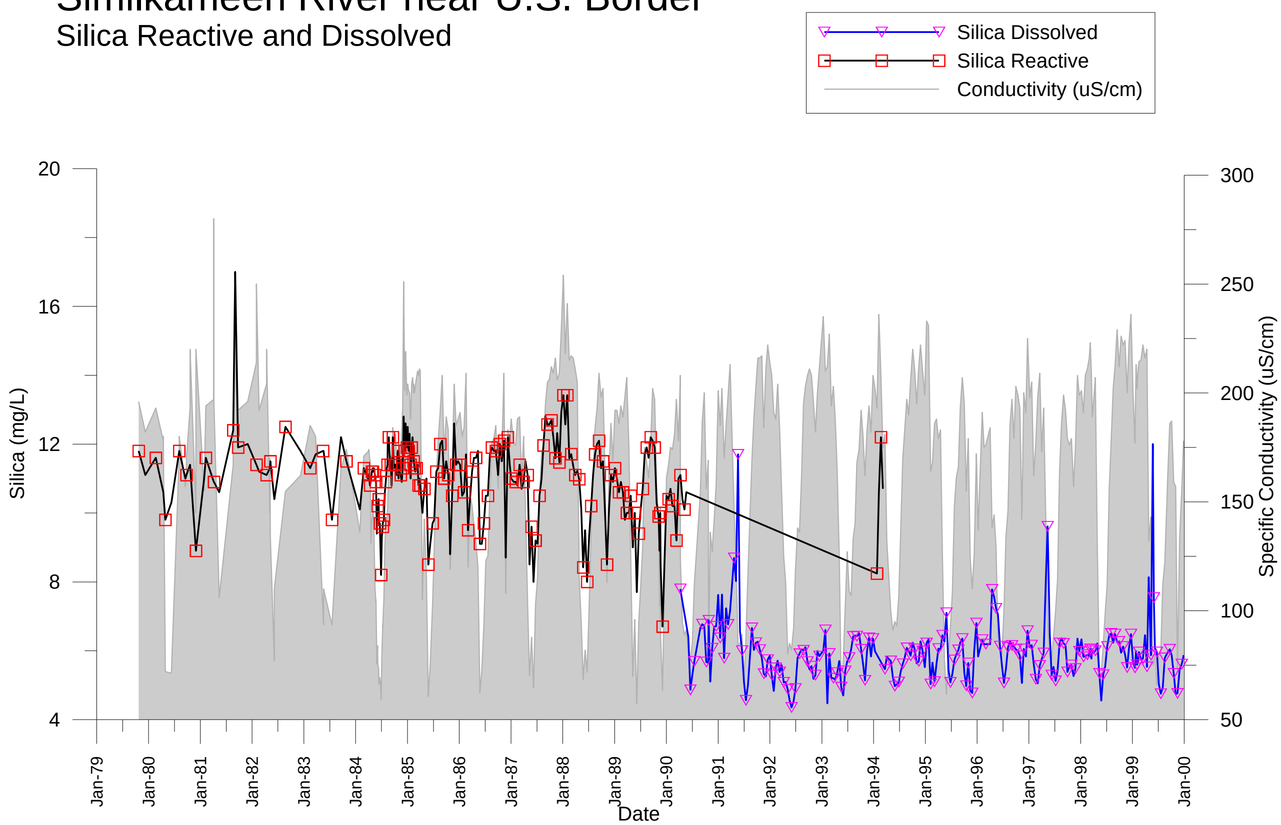


Figure 53
Similkameen River near U.S. Border
Silica Reactive and Dissolved



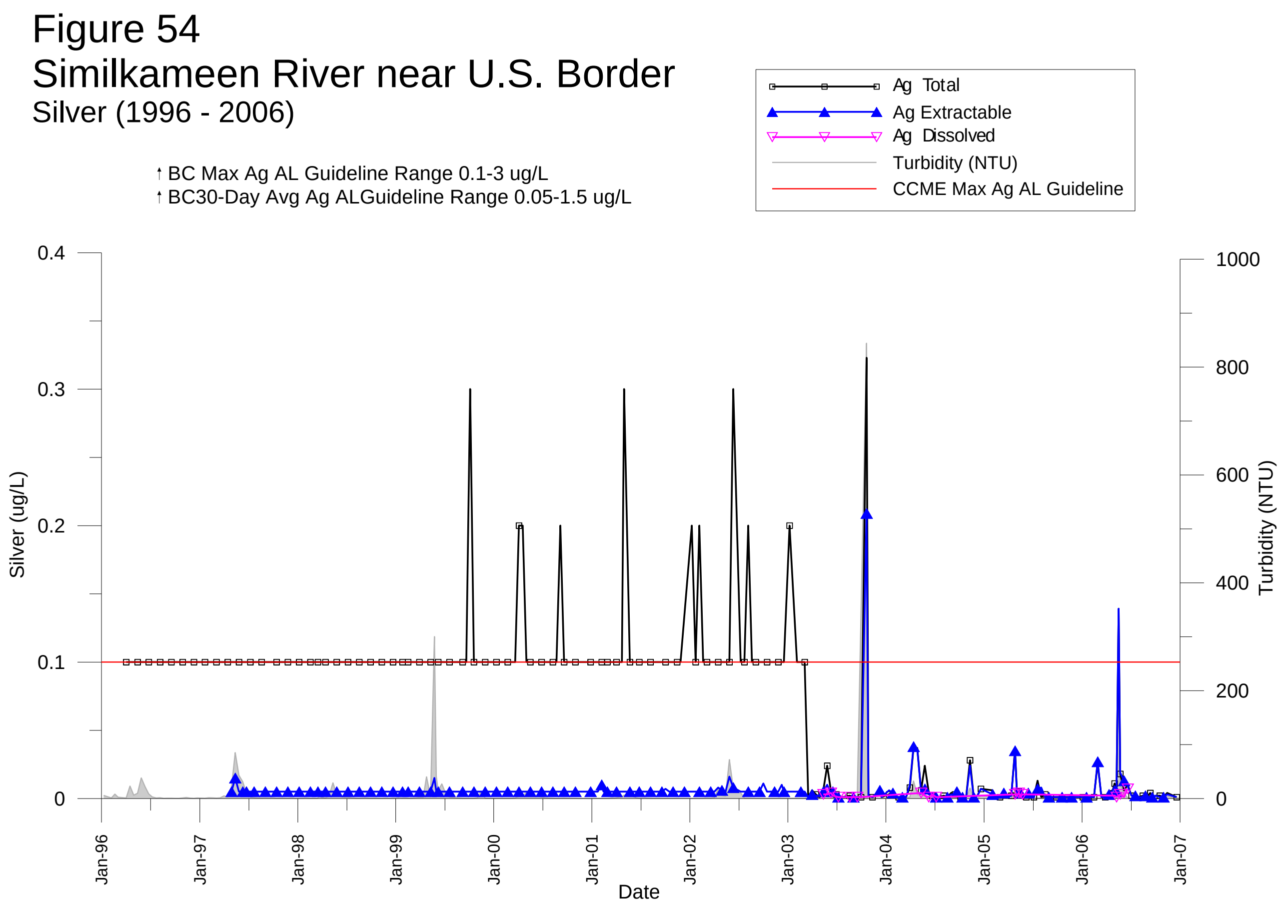


Figure 54
Similkameen River near U.S. Border
Silver (1996 - 2006)
↑ BC Max Ag AL Guideline Range 0.1-3 ug/L
↑ BC30-Day Avg Ag ALGuideline Range 0.05-1.5 ug/L
Ag Total
Ag Extractable
Ag Dissolved
Turbidity (NTU)
CCME Max Ag AL Guideline
Silver (ug/L)
Turbidity (NTU)
Date
0.4
0.3
0.2
0.1
0
1000
800
600
400
200
0
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07

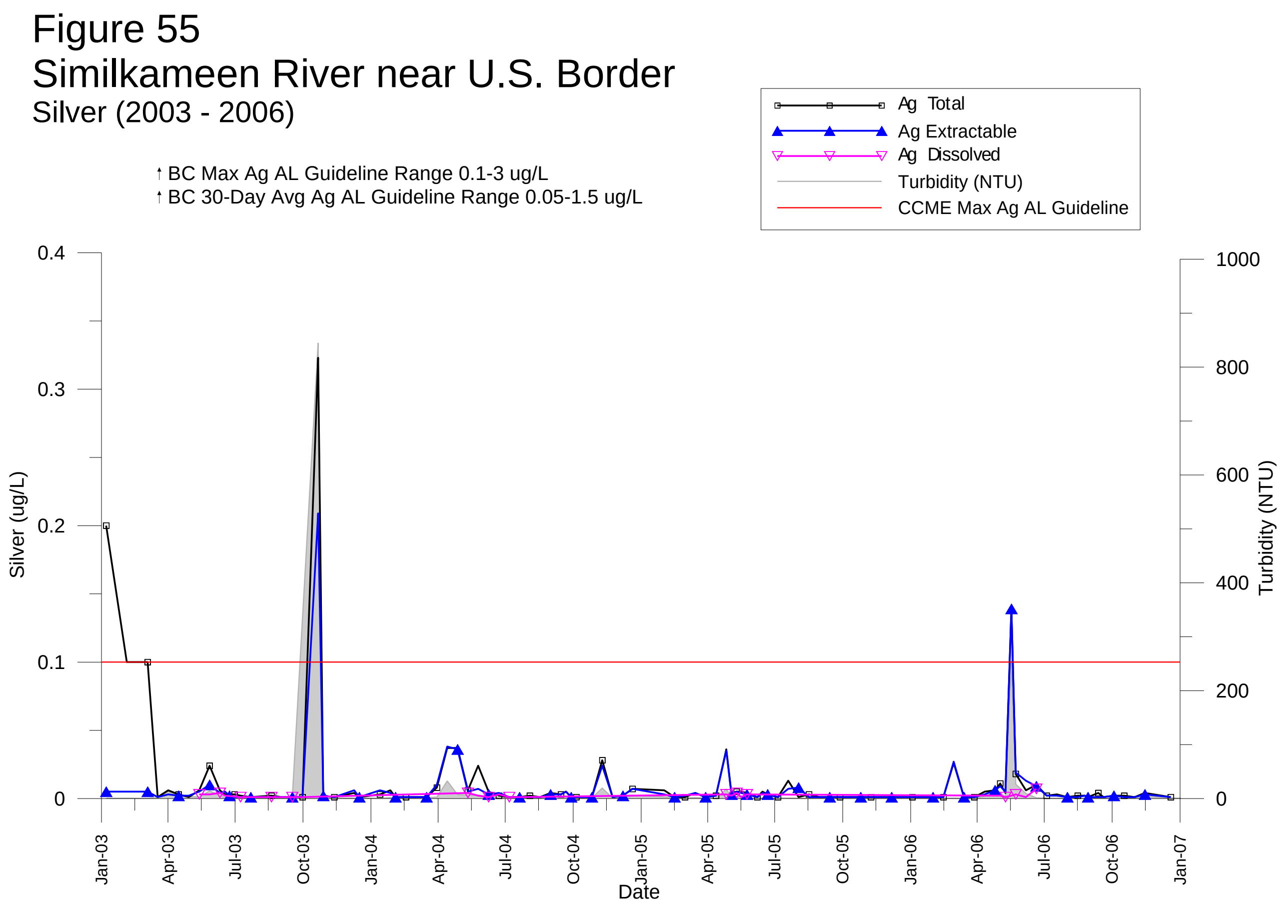
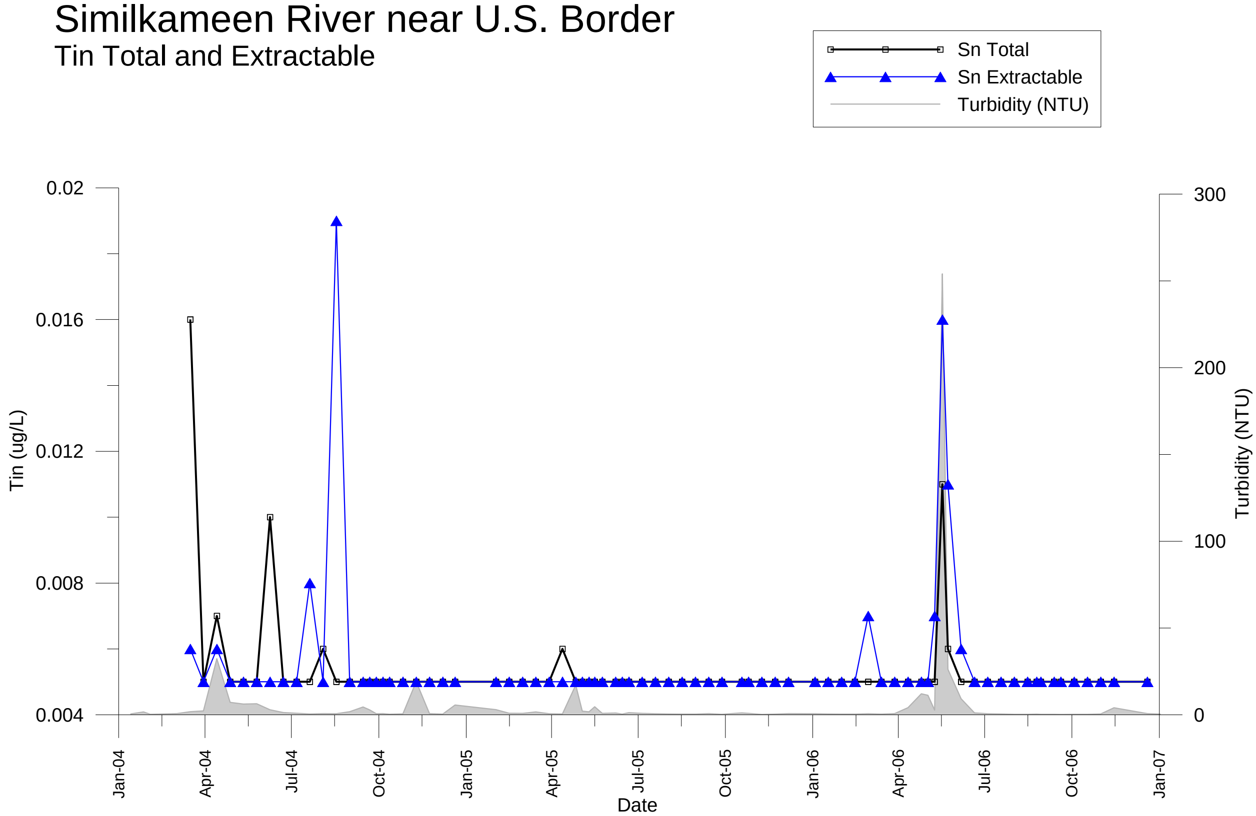


Figure 55
Similkameen River near U.S. Border
Silver (2003 - 2006)
Ag Total
Ag Extractable
Ag Dissolved
Turbidity (NTU)
CCME Max Ag AL Guideline
↑ BC Max Ag AL Guideline Range 0.1-3 ug/L
↑ BC 30-Day Avg Ag AL Guideline Range 0.05-1.5 ug/L
Silver (ug/L)
Turbidity (NTU)
Date
0.4
0.3
0.2
0.1
0
1000
800
600
400
200
0
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05
Apr-05
Jul-05
Oct-05
Jan-06
Apr-06
Jul-06
Oct-06
Jan-07

Figure 56
Similkameen River near U.S. Border
Tin Total and Extractable



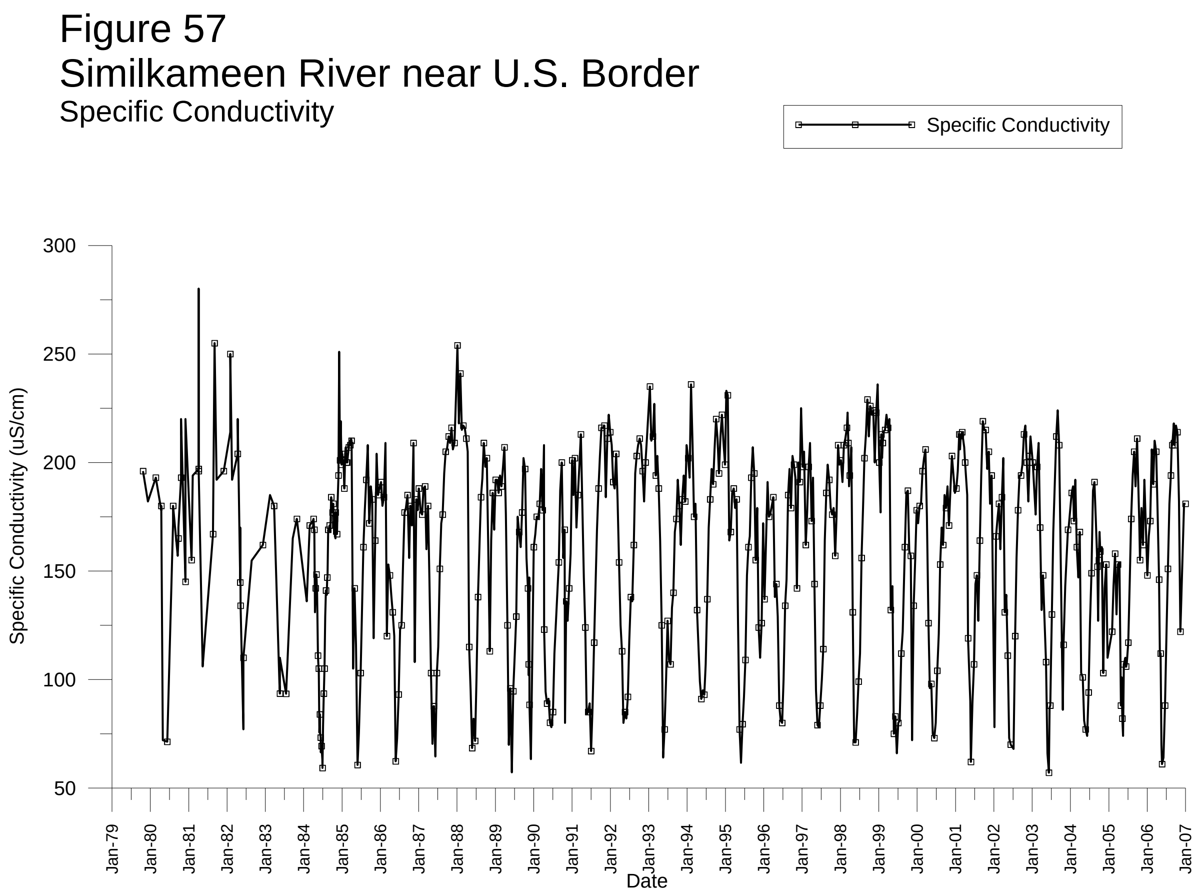


Figure 57
Similkameen River near U.S. Border
Specific Conductivity
Specific Conductivity
300
250
200
150
100
50
Specific Conductivity (uS/cm)
Jan-79
Jan-80
Jan-81
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Date

Figure 58
Similkameen River near U.S. Border
Strontium Extractable, Dissolved and Total

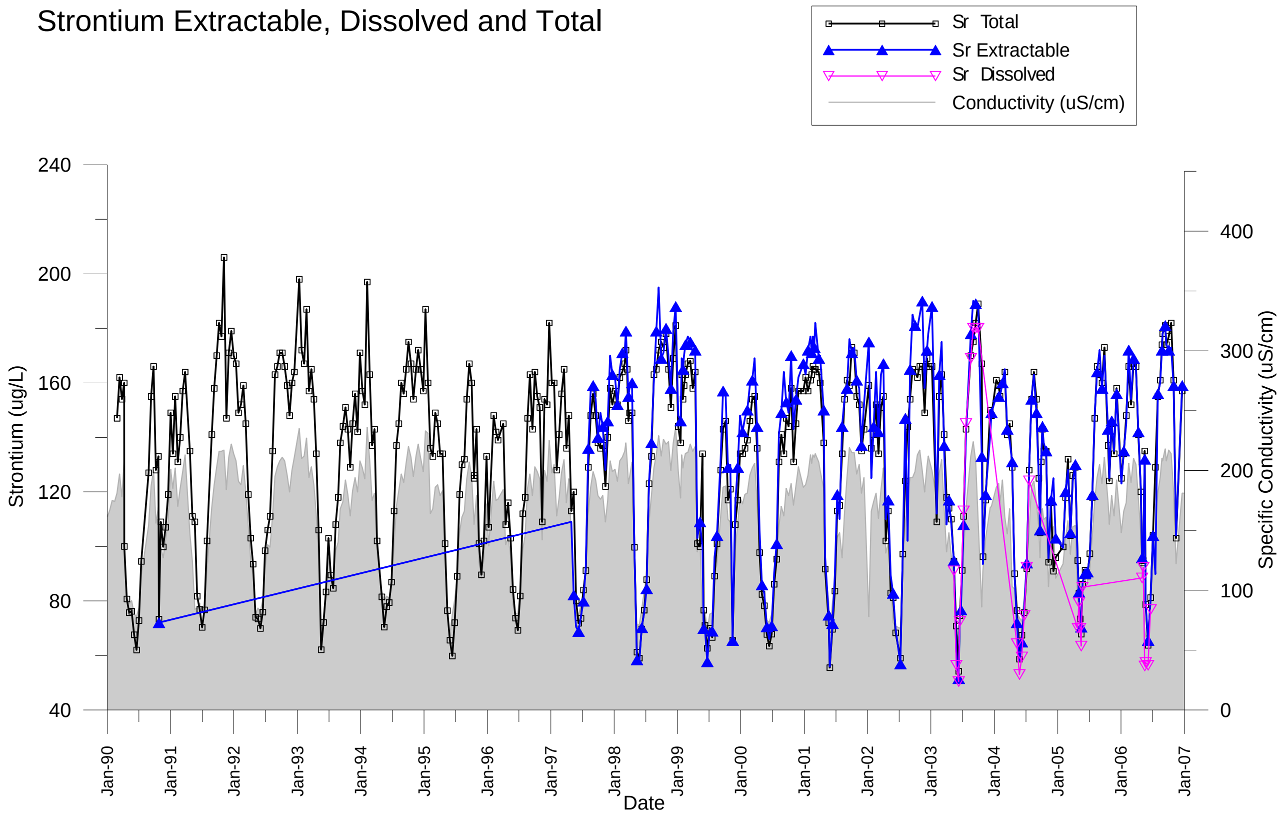


Figure 59
Similkameen River near U.S. Border
Sulphate Dissolved

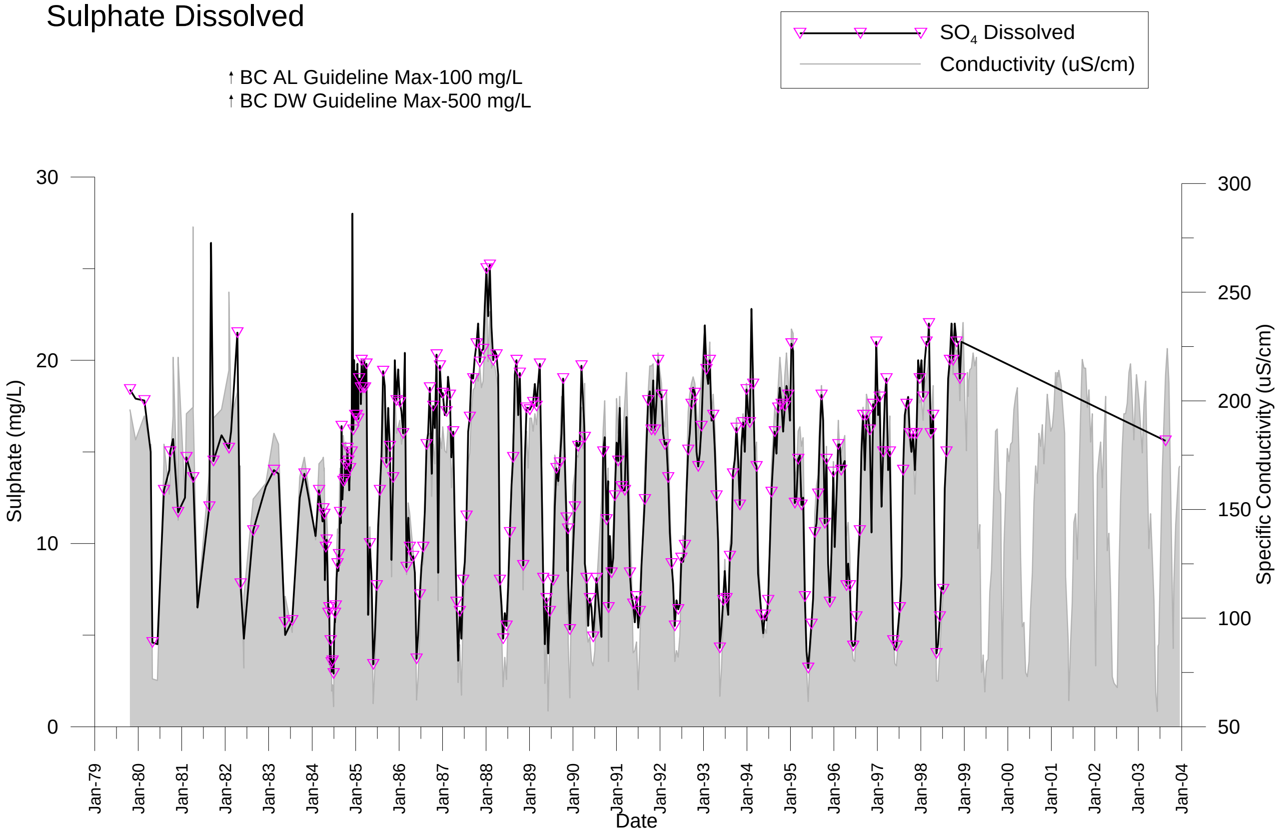


Figure 60
Similkameen River near U.S. Border
Temperature Air and Water

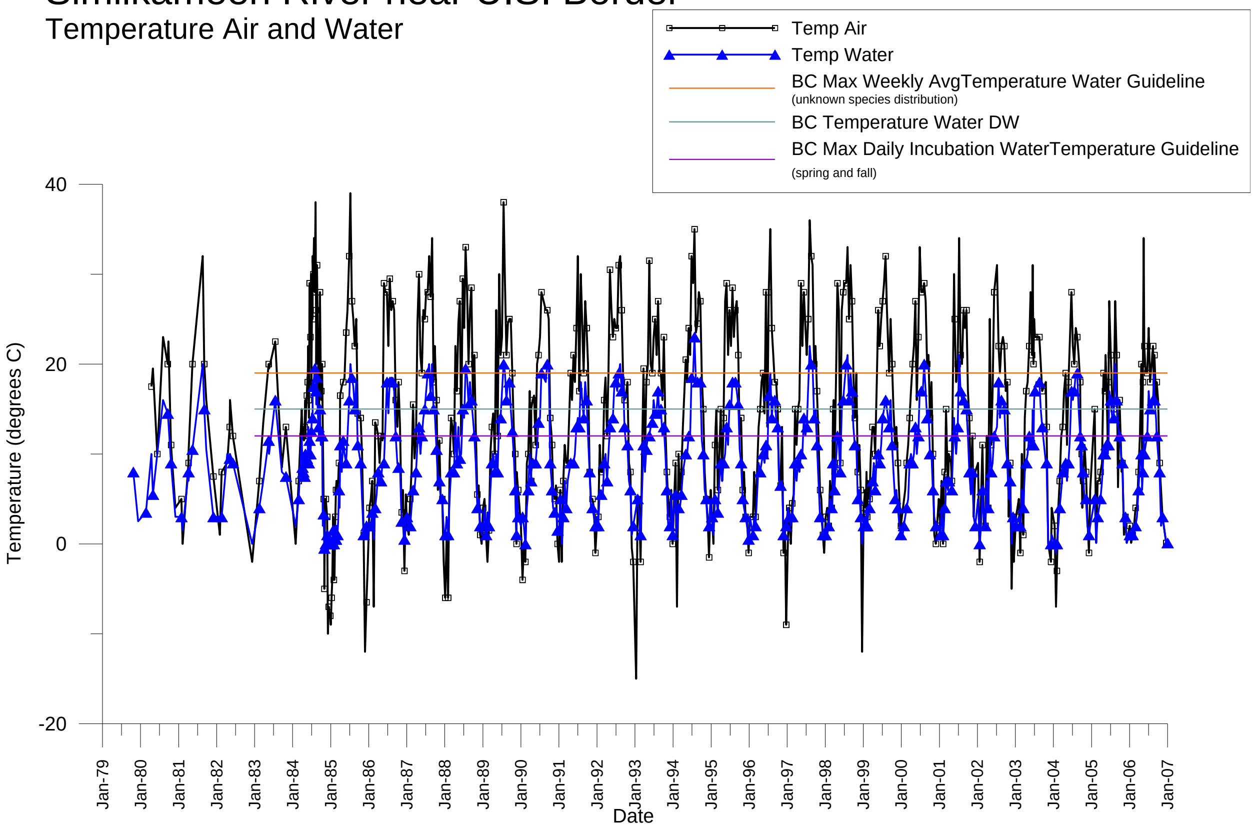


Figure 61
Similkameen River near U.S. Border
Thallium (1997 - 2006)

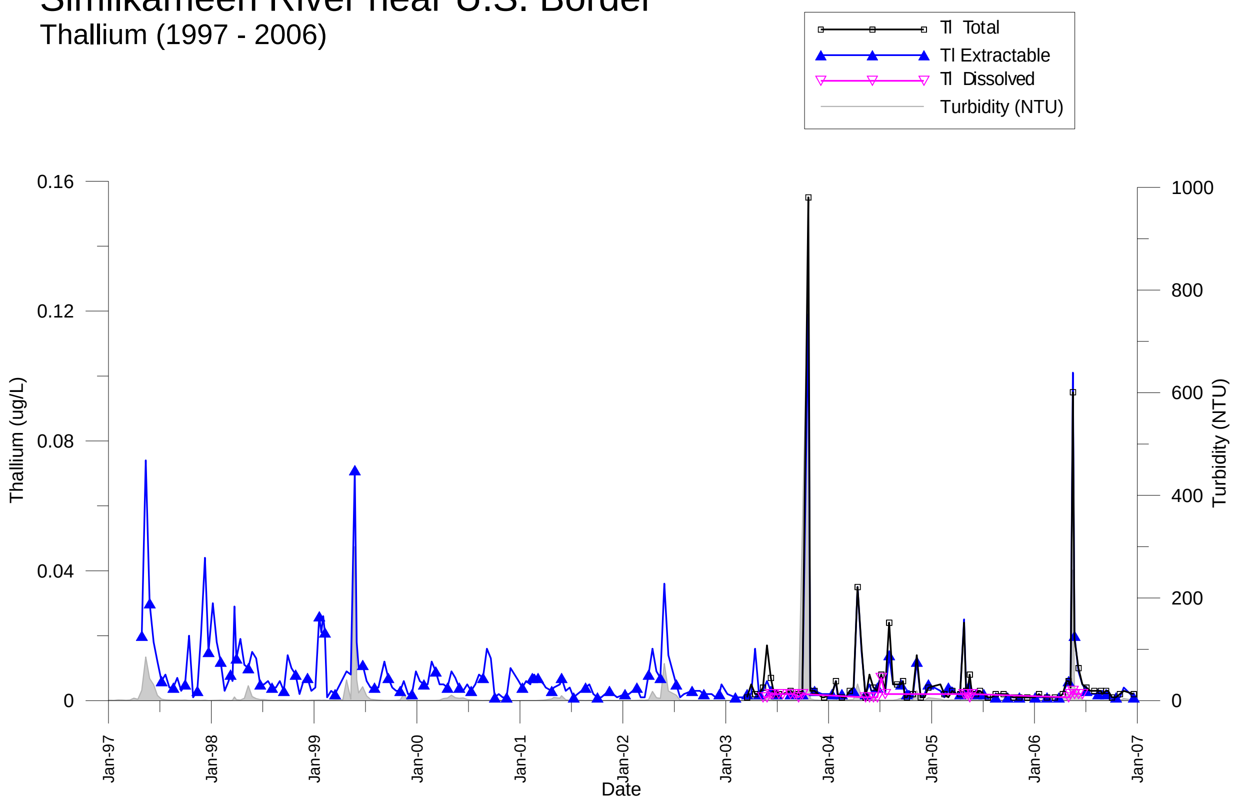
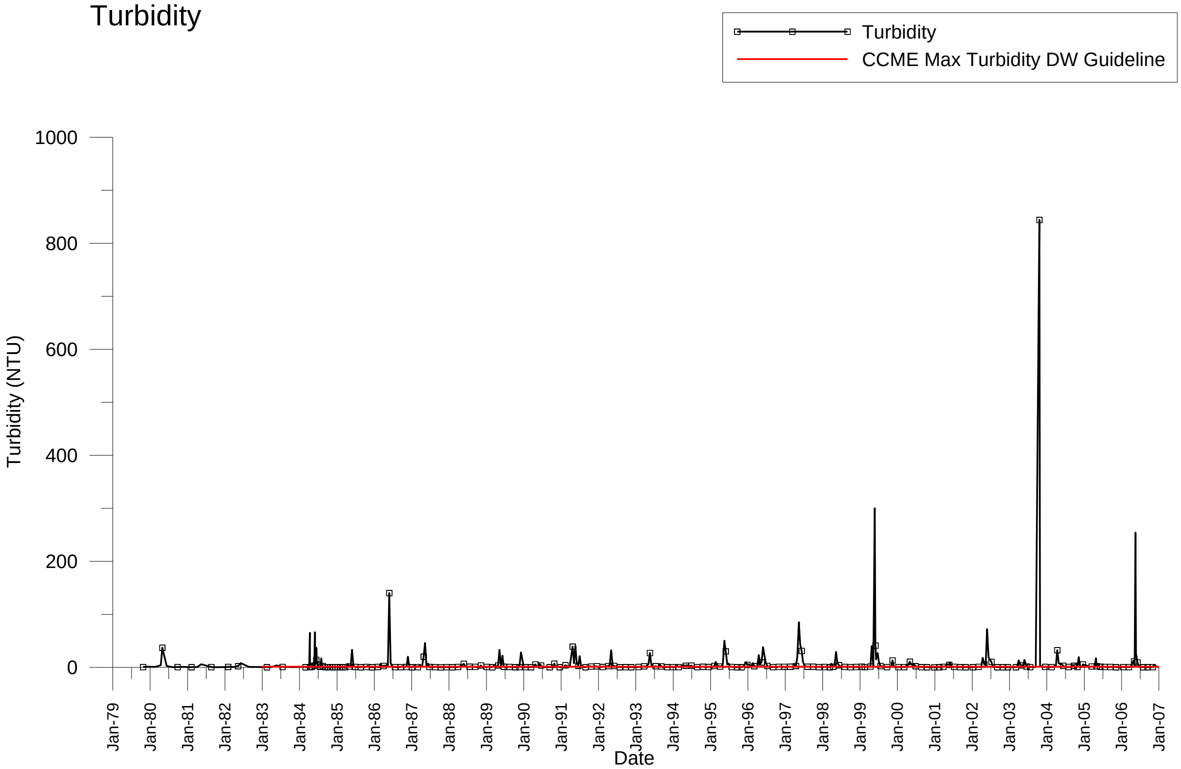


Figure 62
Similkameen River near U.S. Border
Turbidity



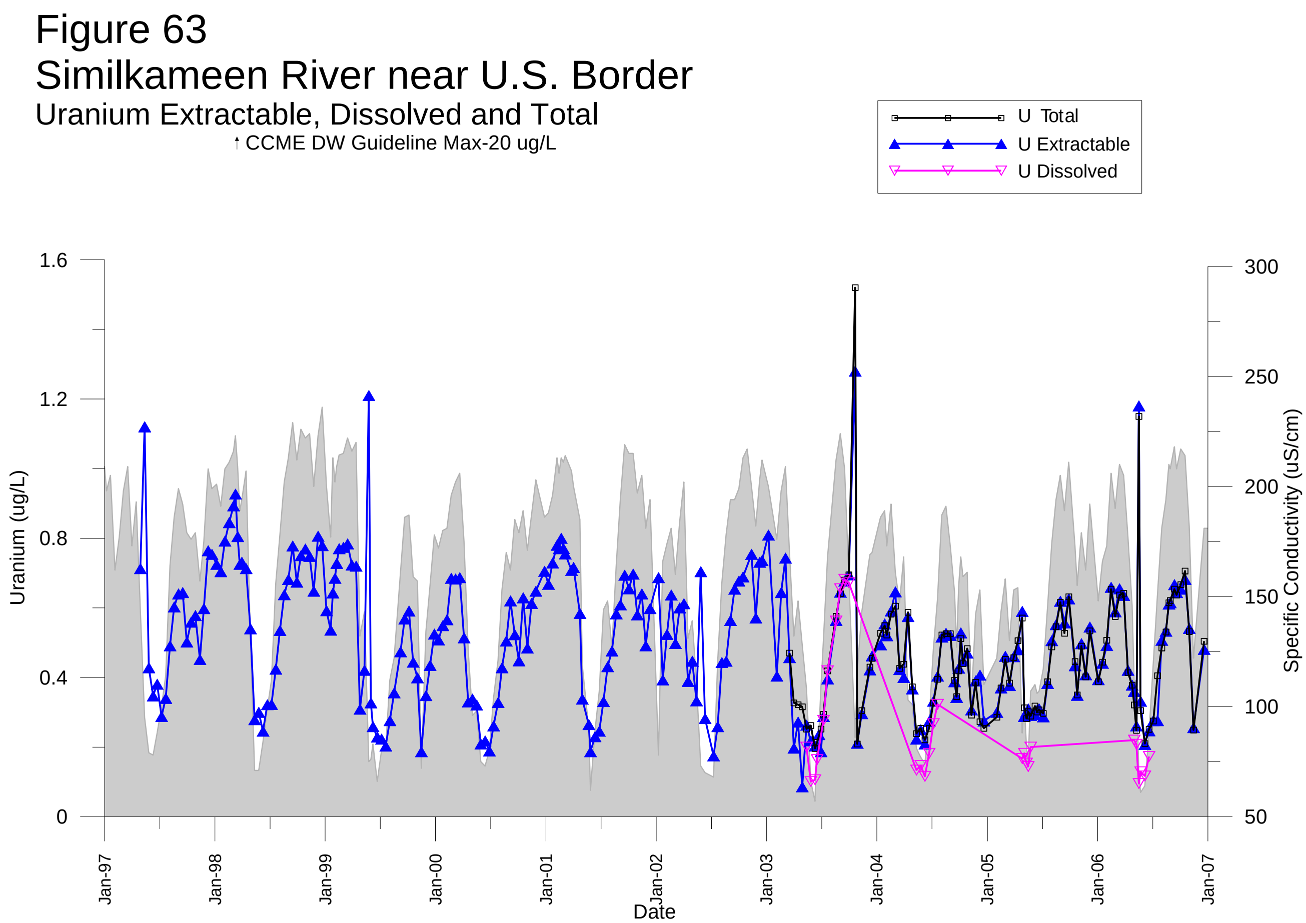


Figure 63
Similkameen River near U.S. Border
Uranium Extractable, Dissolved and Total
↑ CCME DW Guideline Max-20 ug/L
U Total
U Extractable
U Dissolved
Uranium (ug/L)
Specific Conductivity (uS/cm)
Date
1.6
1.2
0.8
0.4
0
300
250
200
150
100
50
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07

Figure 64
Similkameen River near U.S. Border
Vanadium Extractable, Dissolved and Total

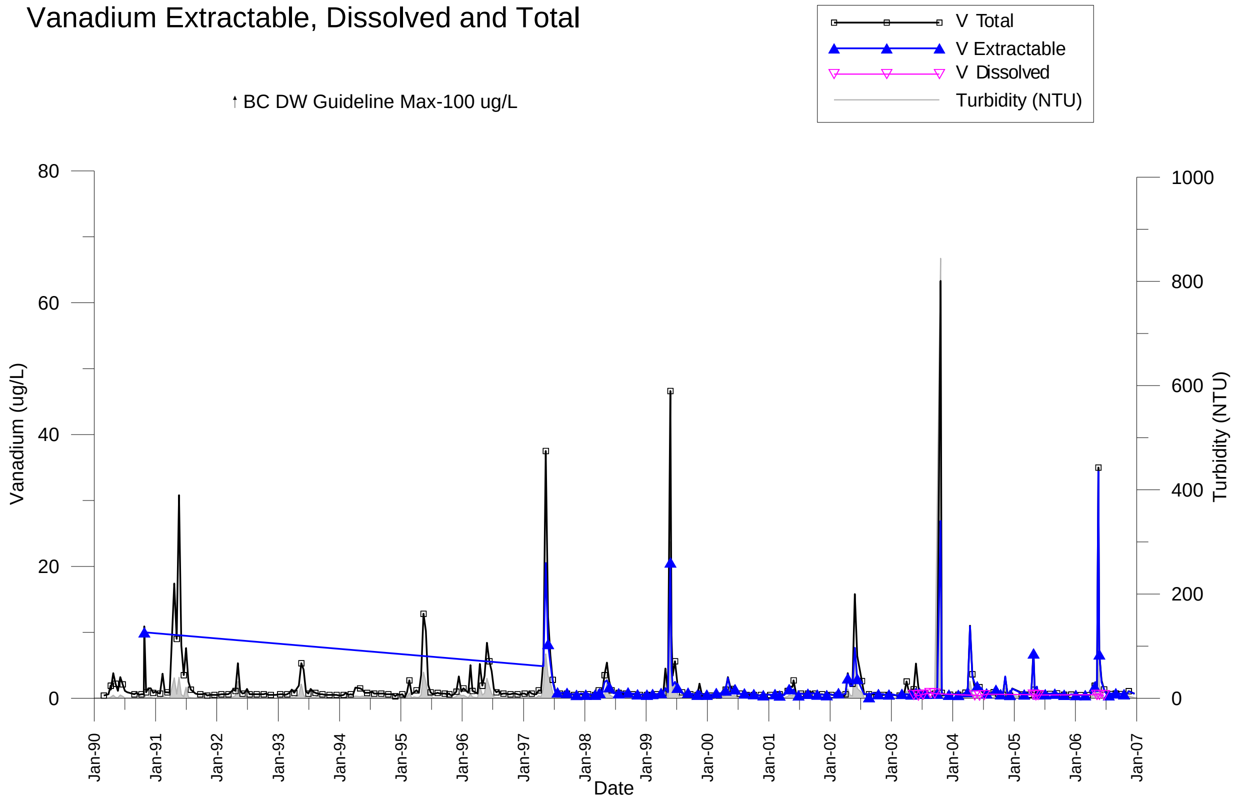


Figure 65
Similkameen River near U.S. Border
Zinc Total and Extractable