CANADA – BRITISH COLUMBIA
WATER QUALITY MONITORING AGREEMENT

WATER QUALITY ASSESSMENT OF KOOTENAY RIVER NEAR FENWICK STATION (1984 – 2005)

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Prepared for:
B.C. Ministry of Environment
and
Environment Canada

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Environment Canada Environnement Canada

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EXECUTIVE SUMMARY

The Kootenay River at Fenwick Station flows in the Rocky Mountain Trench, draining 12,000 km^2 of the Rocky Mountains to the east and the Purcell Mountains to the west. It is a transboundary river, which joins the Elk River in B.C. and flows into Koocanusa Lake. This reach of the Kootenay River supports significant fisheries and is used for irrigation.

The Teck-Cominco Metals Ltd. Sullivan mine, concentrator and former fertilizer complex at Kimberley in the St. Mary River watershed and the Crestbrook Forest Industry Ltd. kraft pulp mill at Skookumchuck have been the main influences on water quality. The Elk River and potential impacts from coal mining drain in downstream from Fenwick.

CONCLUSIONS

- Lithium concentrations seem to be declining through time, possibly due to a lesser impact of groundwater on the flow regime. This needs to be confirmed by a statistician.
- Temperature generally exceeds guidelines during warmer summer months.
- Turbidity values generally exceed the guideline for the protection of source waters used for drinking, meaning that if suspended solids removal is not used, disinfection of water supplies could be compromised.
- Otherwise, water quality was generally good with only occasional values exceeding guidelines for pH, fecal coliforms, several metals, dissolved organic carbon, and true colour. In cases where total metal concentrations exceeded guideline values, these were generally correlated with higher turbidity concentrations, meaning that the metals were likely in particulate form and not biologically available

RECOMMENDATIONS

We recommend monitoring be continued for the Kootenay River near Fenwick Station since it is a trans-boundary site and to ensure that lithium either levels out or continues to decrease.

Water quality indicators that are important for future monitoring are:

- flow, water temperature, specific conductivity, pH, turbidity, nutrients, and dissolved oxygen,
- phosphorus, sodium and selenium,
- 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 Jolene Raggett of BC Environment and Andrea Ryan of Environment Canada. We thank these individuals for their contributions to improving this document. Tri-Star Environmental Consulting performed the final edits for the report. 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 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. This assessment is based on up to 22 years of water quality data during 1984-2005.

The Fenwick Station is located on the Kootenay River , which flows in the Rocky Mountain Trench, draining 12,000 km^2 of the Rocky Mountains to the east and the Purcell Mountains to the west. It is a transboundary river, which joins the Elk River in B.C. and flows into Koocanusa Lake. This reach of the Kootenay River supports significant fisheries and is used for irrigation.

The Teck Cominco Metals Ltd. Sullivan mine, concentrator and former fertilizer complex at Kimberley in the St. Mary River watershed and the Crestbrook Forest Industry Ltd. kraft pulp mill at Skookumchuck have been the main influences on water quality. The Elk River and potential impacts from coal mining drain in downstream from Fenwick.

Water quality measurements for the Kootenay River near Fenwick Station were plotted on a graph over time, along with the relevant water quality objectives or guidelines. The graphs were inspected for "environmentally significant" trends - where the measurements are increasing or decreasing over time and the levels are close to the objectives or guidelines, or are otherwise judged to represent an important change in water quality. 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.

The water quality sampling station on the Kootenay River is located six kilometres downstream from Fort Steele. Samples are collected from the right bank (looking upstream).

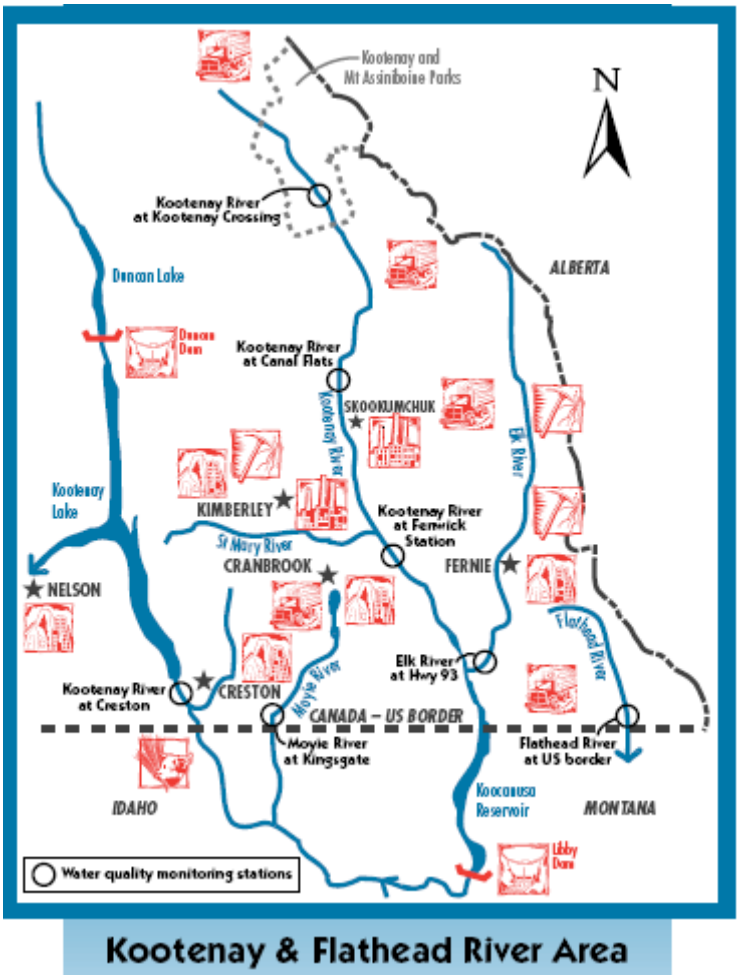


FIGURE 1: KOOTENAY RIVER NEAR FENWICK STATION

WATER QUALITY ASSESSMENT

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. 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 cases where we have used statistical techniques such as linear regression analysis to estimate if a trend is possibly present, a more thorough statistical analysis of the trend is necessary for verification of the possible trend.

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.

Data for the Kootenay River near Fenwick Station 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 three times per year. Results for each variable were used in this assessment to identify potential outliers that should be removed from consideration of

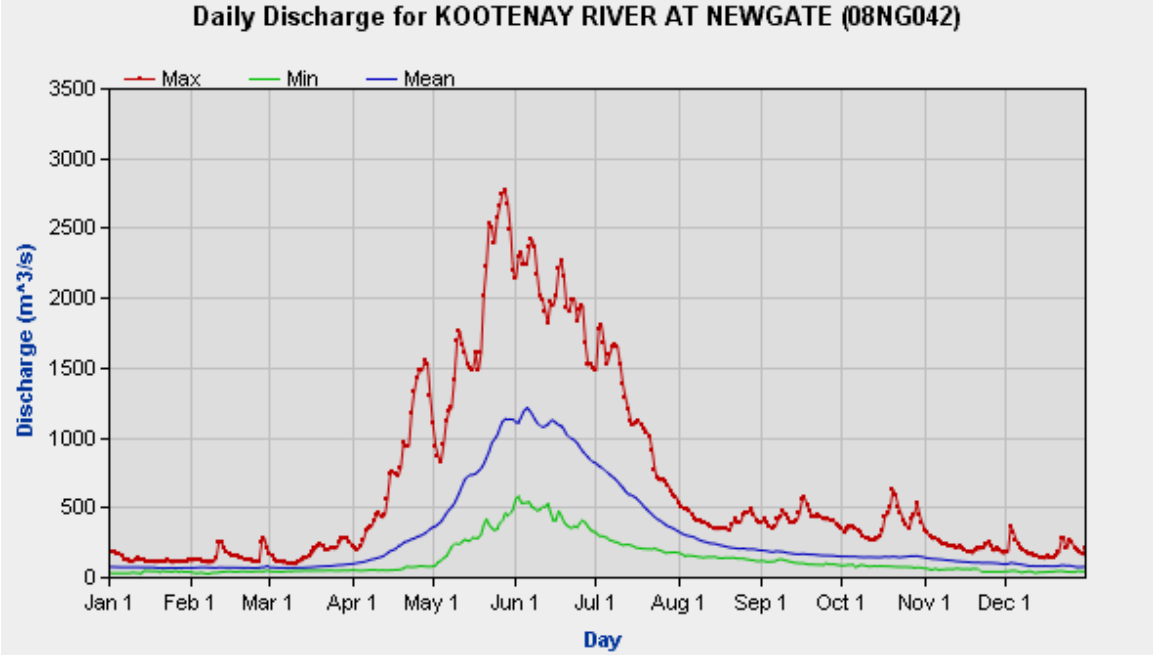
trends, and to "flag" questionable data in the database (www.waterquality.ec.gc.ca) as to possible or likely errors.

The following water quality indicators were not discussed as they met all water quality guidelines (if guidelines exist) and showed no clearly visible trends: phenolphthalein alkalinity, ammonia, total and extractable antimony, bromine, ortho phosphate, selenium, 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: total and extractable arsenic, total and extractable beryllium, total and extractable bismuth, cobalt, copper, gallium, lanthanum, manganese, nickel, niobium, total phosphorus, non-filterable and fixed non-filterable residue, rubidium, silver, thallium, vanadium, and zinc.

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 total alkalinity, total and extractable barium, total and extractable boron, dissolved and extractable calcium, dissolved inorganic carbon, chloride, fluoride, hardness, magnesium, molybdenum, dissolved nitrate, total dissolved nitrogen, pH, dissolved ortho phosphorus, potassium, filterable and fixed filterable residue, silica, silicon, sodium, strontium, sulphate, and uranium.

Flow (Figure 2) values showed fairly typical patterns characteristic of an interior river, with freshet taking place between May through July. Average flows through the year are in the order 700m^3/s at Fort Steele but nearly 1200 m^3/s at Newgate (Fenwick Station is located between these two sites). At low flows, mean recordings are about 40 m^3/s at Fort Steel and 70 m^3/s at Newgate.



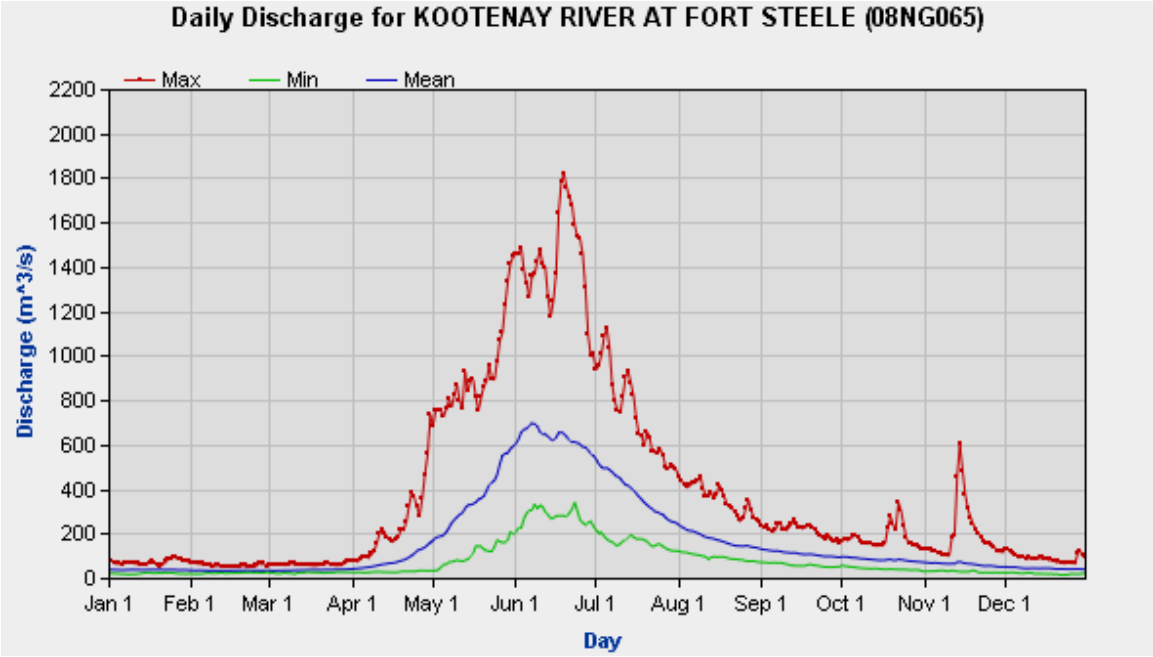


FIGURE 2: WATER SURVEY OF CANADA FLOW DATA FOR KOOTENAY RIVER AT FORT STEELE AND NEWGATE

Aluminum (Figure 5) values when measured as total or extractable concentrations frequently exceeded the guideline for the protection of aquatic life and source waters used for drinking. However, concentrations were correlated with higher turbidity concentrations, meaning that the aluminum was likely in particulate form and not biologically available. Thus there is no concern for aquatic life.

Cadmium (Figures 21 and 22) concentrations usually met the guideline for the protection of aquatic life, especially since 2003 when analytical detection limits were lowered. Concentrations seemed to be correlated with higher turbidity values, meaning that the cadmium was likely in particulate form and not biologically available.

Dissolved Organic Carbon (Figure 26) values exceeded the guideline to protect source waters used for drinking on only one occasion. This means that there will not be a concern for the formation of disinfection byproducts.

Chromium (Figures 28 and 29) values occasionally exceeded the hexavalent and trivalent chromium guidelines; however, higher values seem to be correlated with higher turbidity concentrations. The high concentrations are likely in particulate form and not biologically available.

Fecal Coliforms (Figure 32) have occasionally exceeded the guideline for the protection of source waters used for drinking with no treatment other than disinfection. The guideline for partial treatment has always been met. Concentrations seemed to be correlated with turbidity levels; and values in 2004 and 2005 were higher than from 2000 to 2003. The period of record is too short to make any firm conclusions regarding increasing trends.

Colour (Figure 35) values when measured as true colour exceeded the guideline for source waters used for drinking on only one occasion. Colour values were correlated with turbidity levels.

Iron (Figures 42 and 43) values regularly exceeded the guidelines of 300 µg/L for the protection of aquatic life and source waters used for drinking (aesthetic concerns). High iron concentrations were correlated with high turbidity values, indicating that the iron is likely in particulate form and not biologically available. As well, if steps are taken to remove turbidity before using the water for drinking, aesthetic concerns will likely be eliminated.

Lead (Figures 46 and 47) concentrations were generally correlated to high turbidity levels. Concentrations infrequently exceeded the guidelines for the protection of aquatic life. Since high concentrations are correlated with high turbidity levels, the lead at those times is likely in particulate matter and not biologically available.

Lithium (Figures 48 and 48) showed a possible declining trend in concentrations over time. When a linear regression analysis of the data from 1990 to 2005 was performed, it was determined that a declining trend with a R^2 value of 0.23 existed. This is considerably less than found at the downstream Creston station where the R^2 value was 0.07. High lithium values seemed to be correlated with higher specific conductivity values. This implies that higher values are associated with groundwater (water of higher hardness) contributions which may be declining relative to surface runoff as a source of flows in the river.

Temperature (Figure 83) values sometimes exceeded guidelines for different fish species; however, these high values were recorded coincident to high air temperatures.

Turbidity (Figure 88) values were regularly higher than the guideline for source waters used for drinking. This means that for effective disinfection of this source water, that solids removal will be required as treatment.

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Figure 3
Kootenay River near Fenwick Station
Alkalinity Phenolphthalein

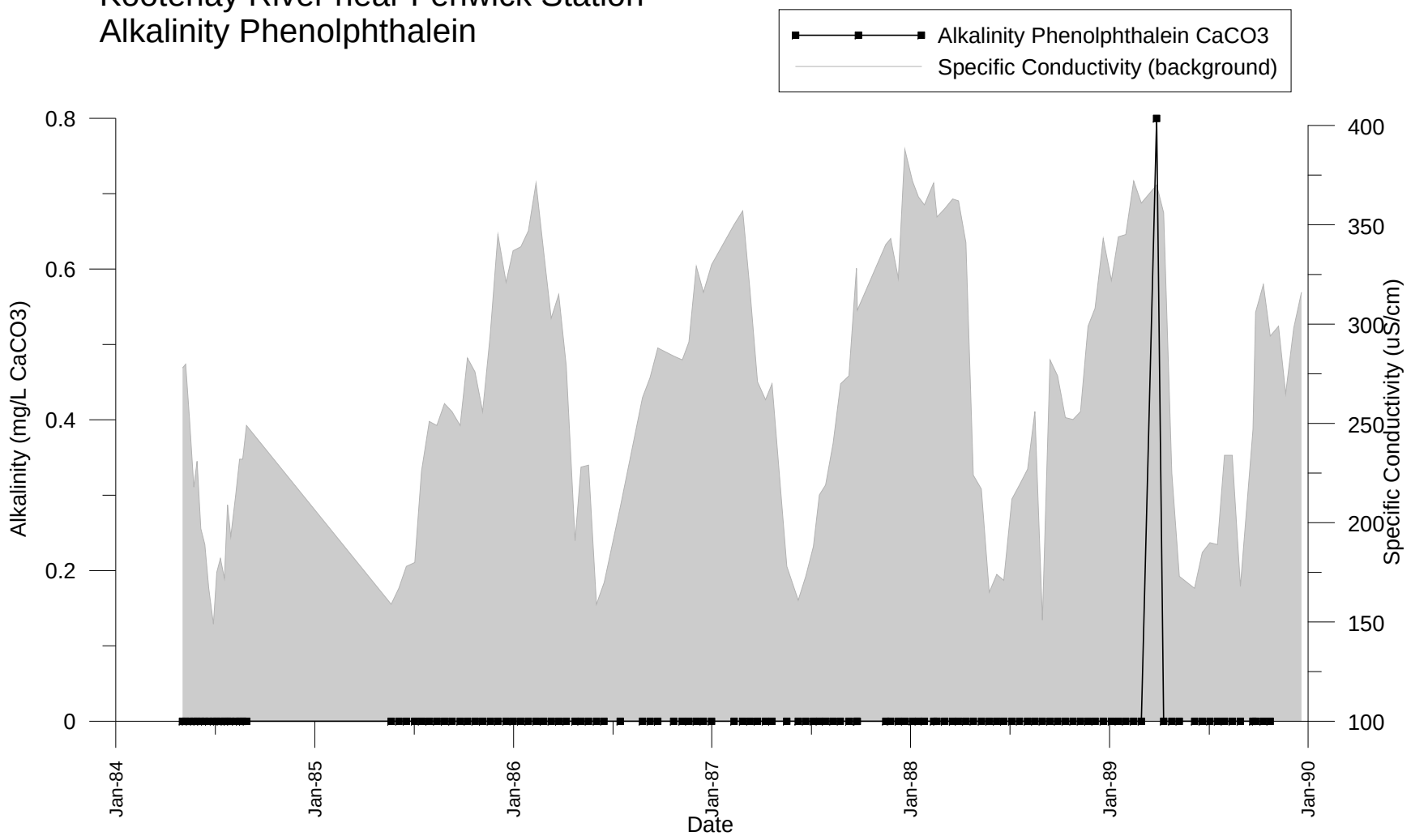

Figure 4
Kootenay River near Fenwick Station
Alkalinity Total

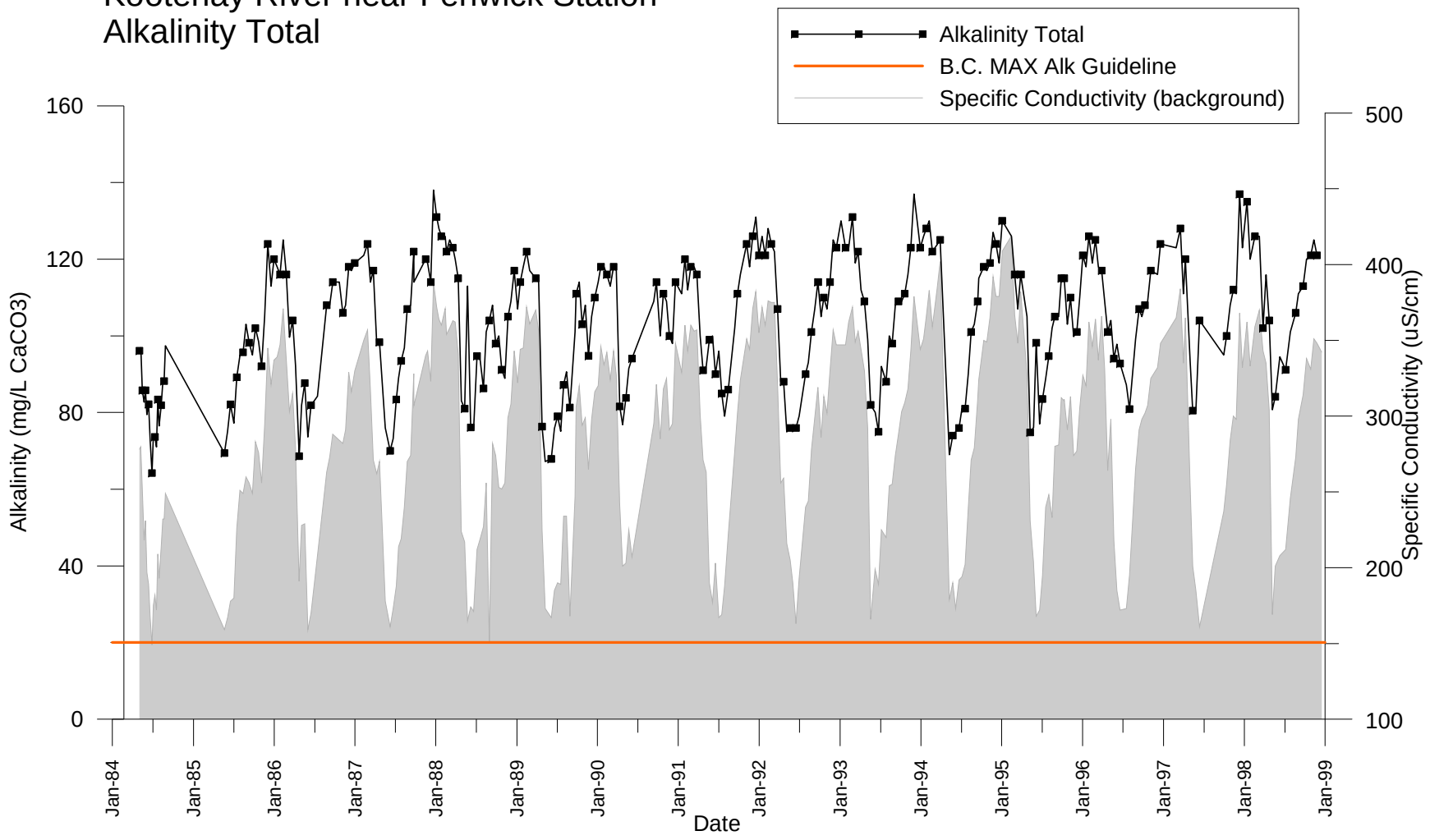

Figure 5
Kootenay River near Fenwick Station
Aluminum Total and Extractable

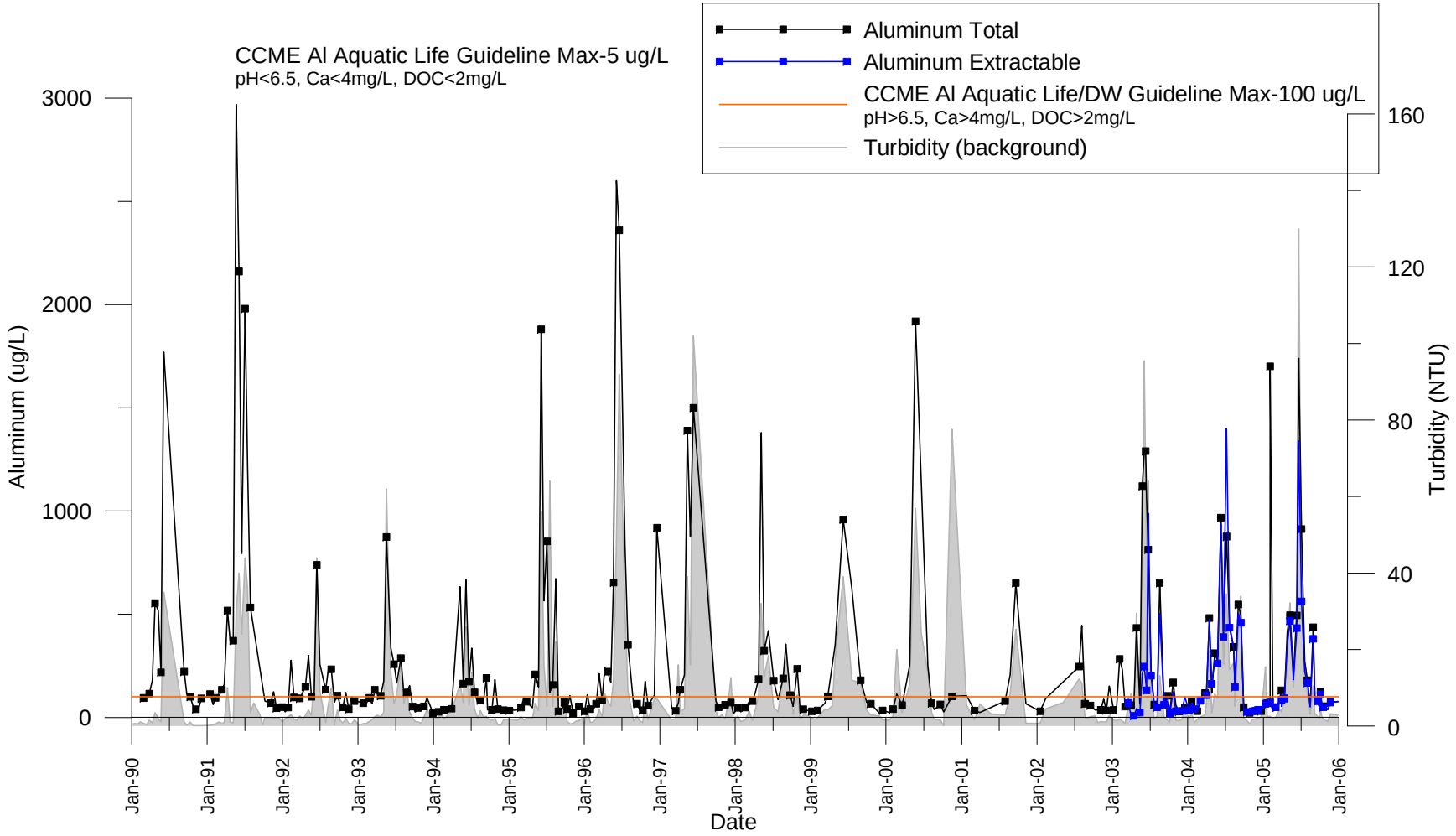

Figure 6
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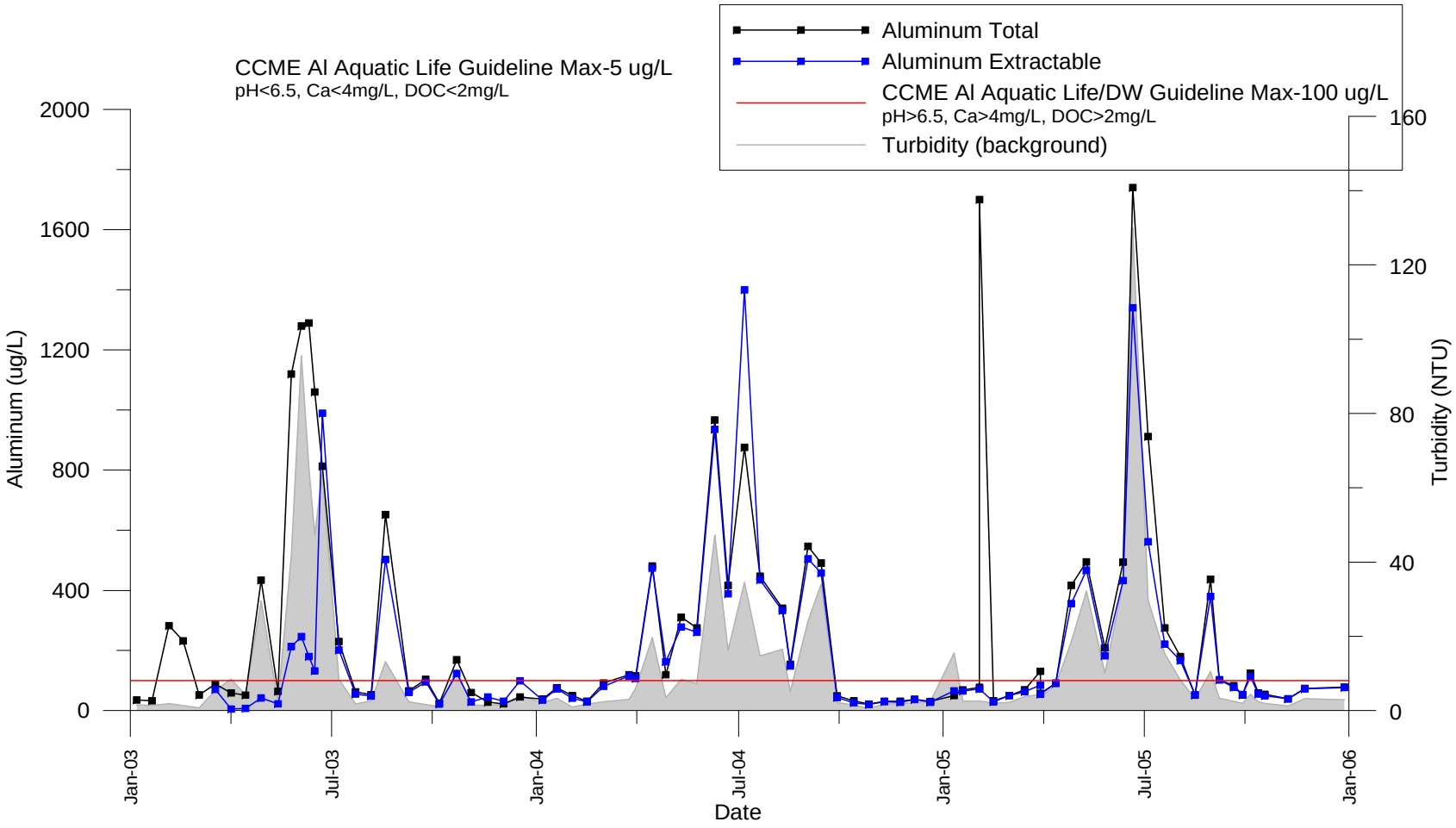


Figure 7
Kootenay River near Fenwick Station
Ammonia Dissolved

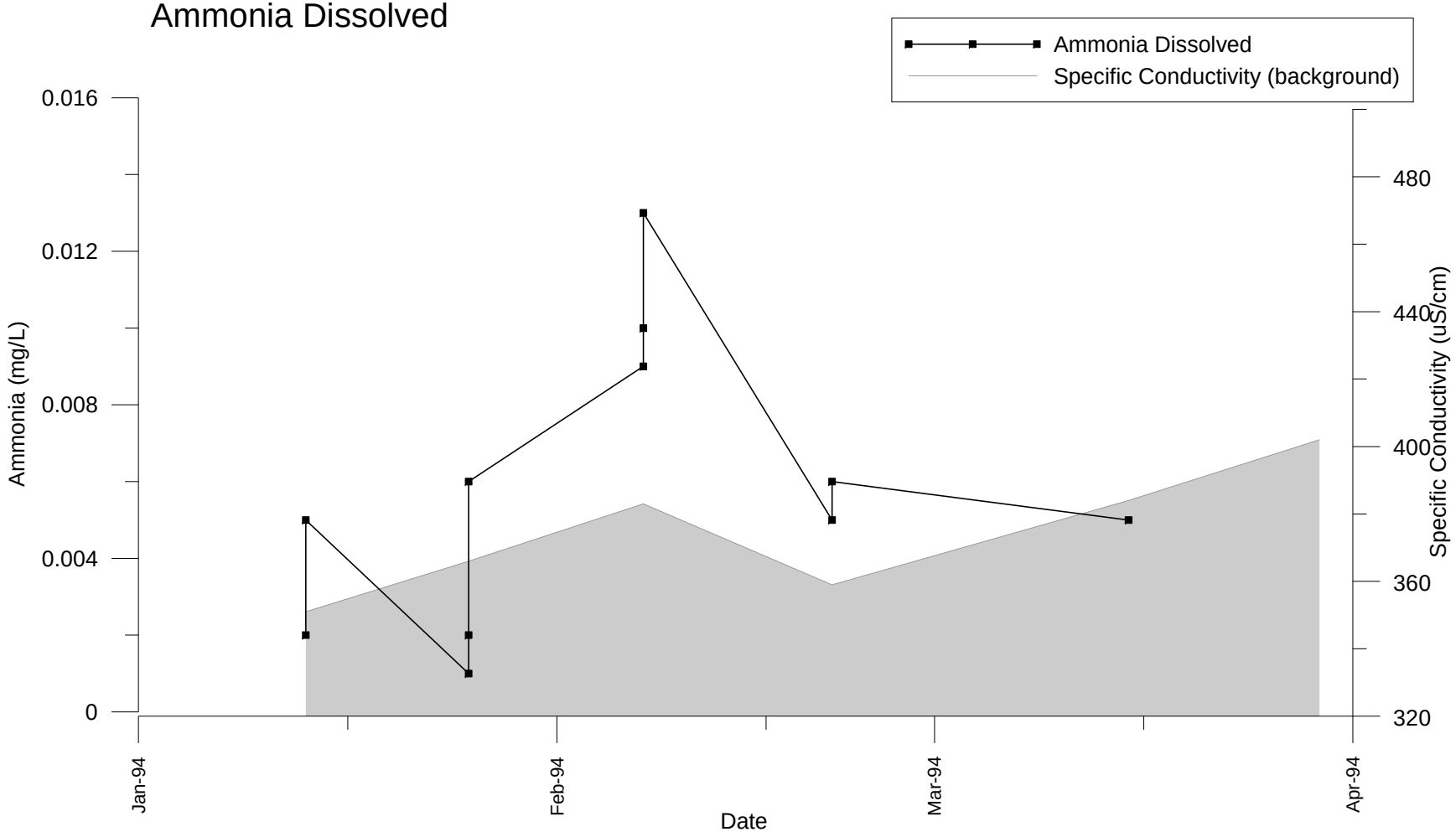
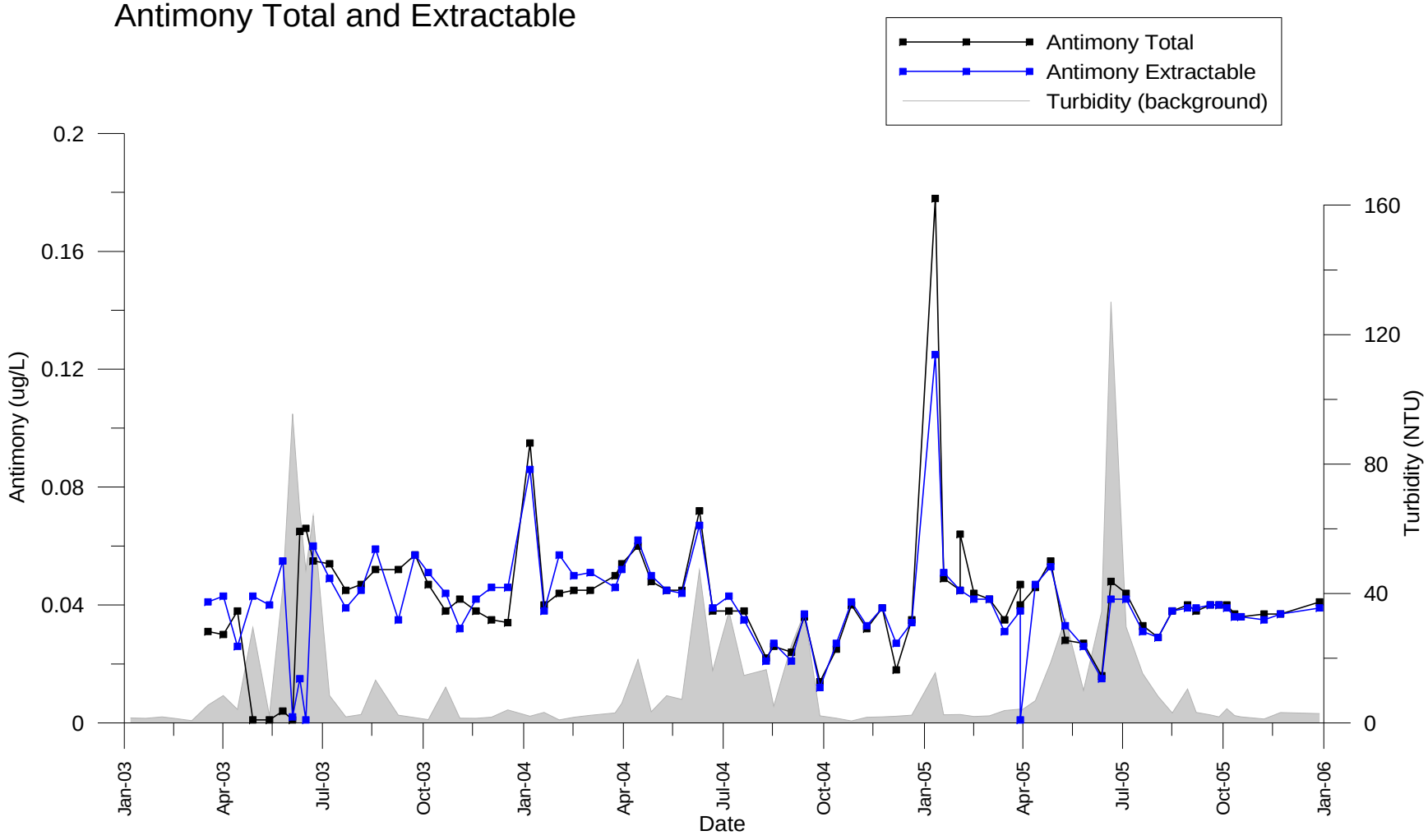


Figure 8
Kootenay River near Fenwick Station
Antimony Total and Extractable



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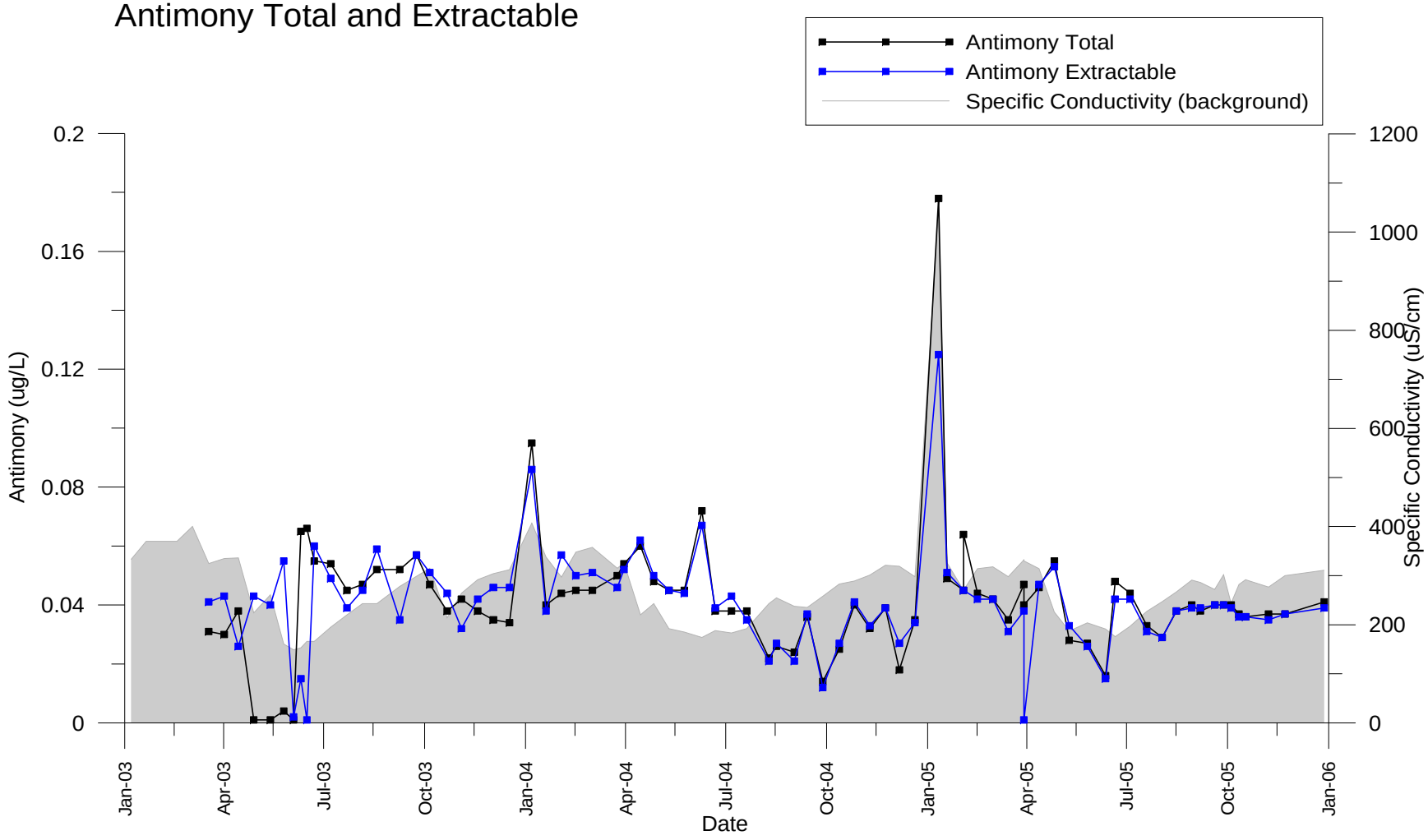

Figure 10
Kootenay River near Fenwick Station
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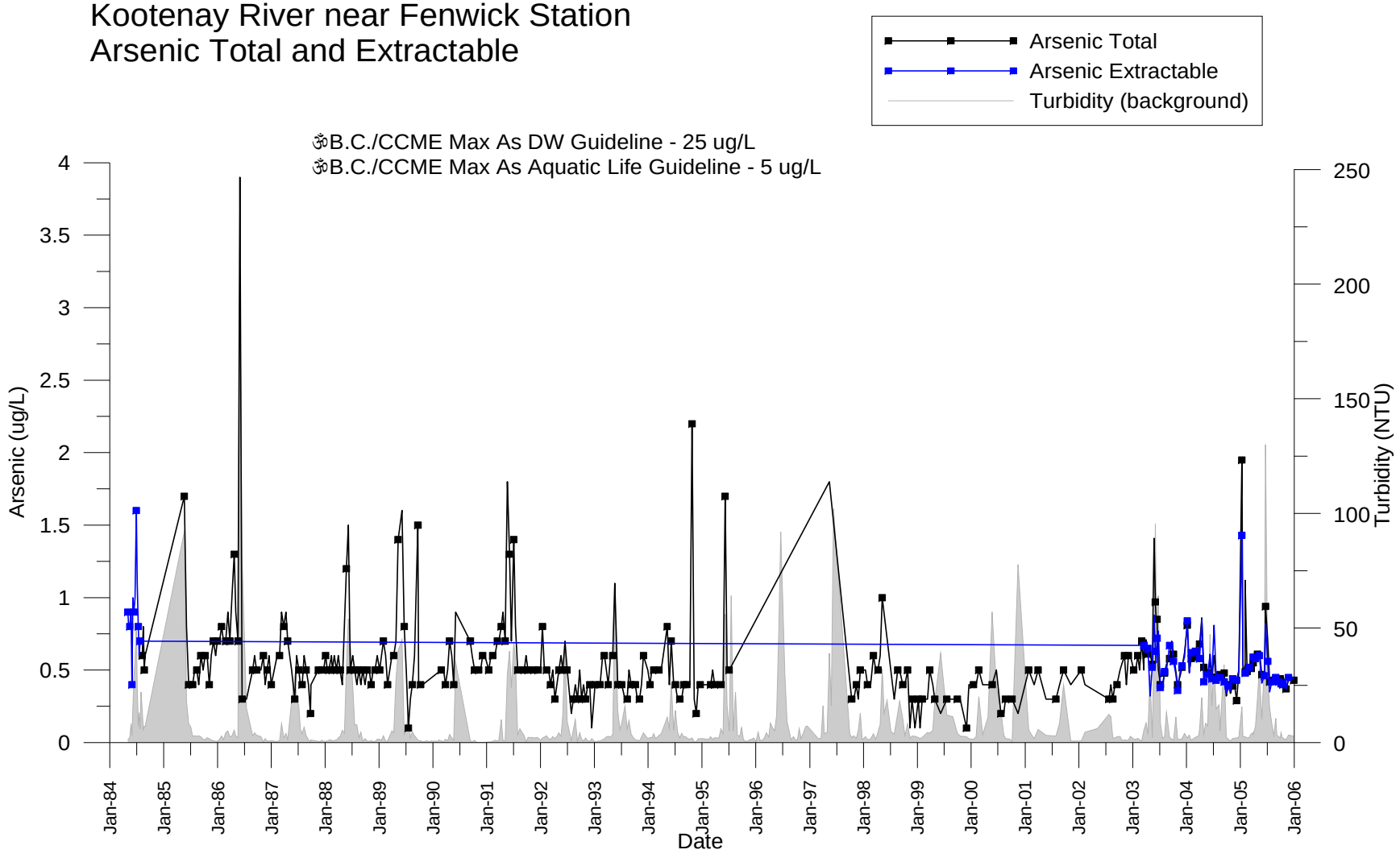

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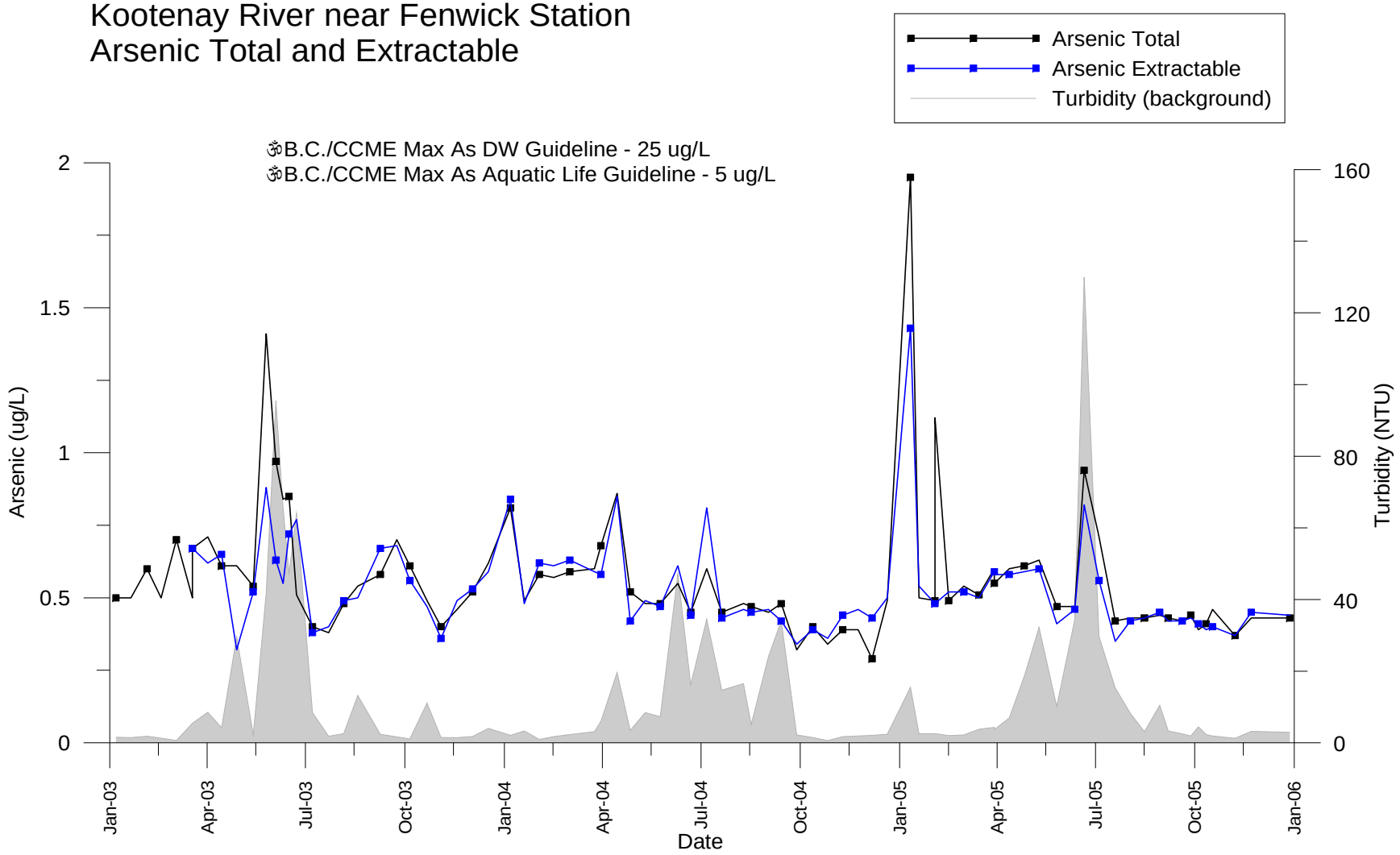

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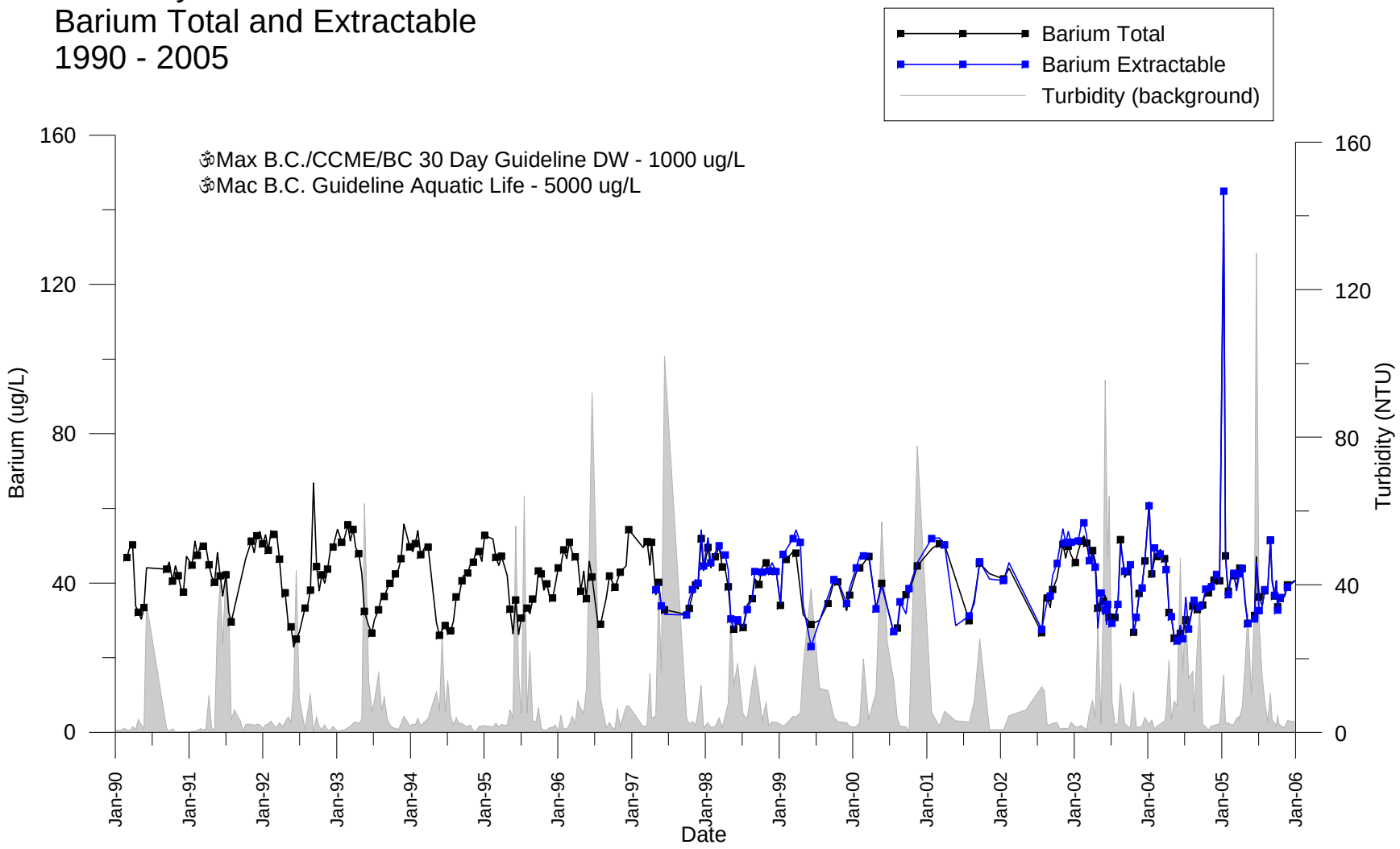

Figure 13
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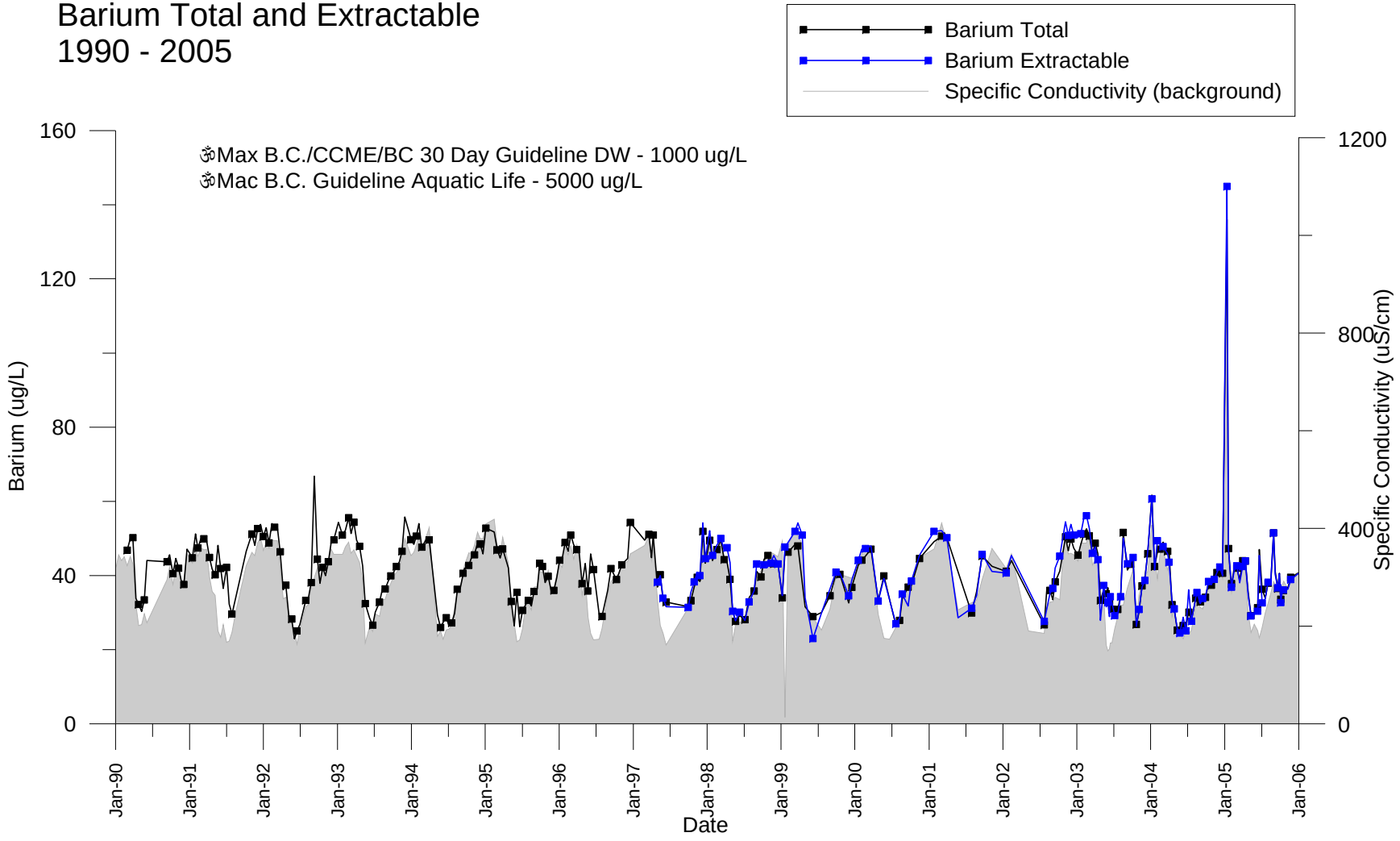

Figure 14
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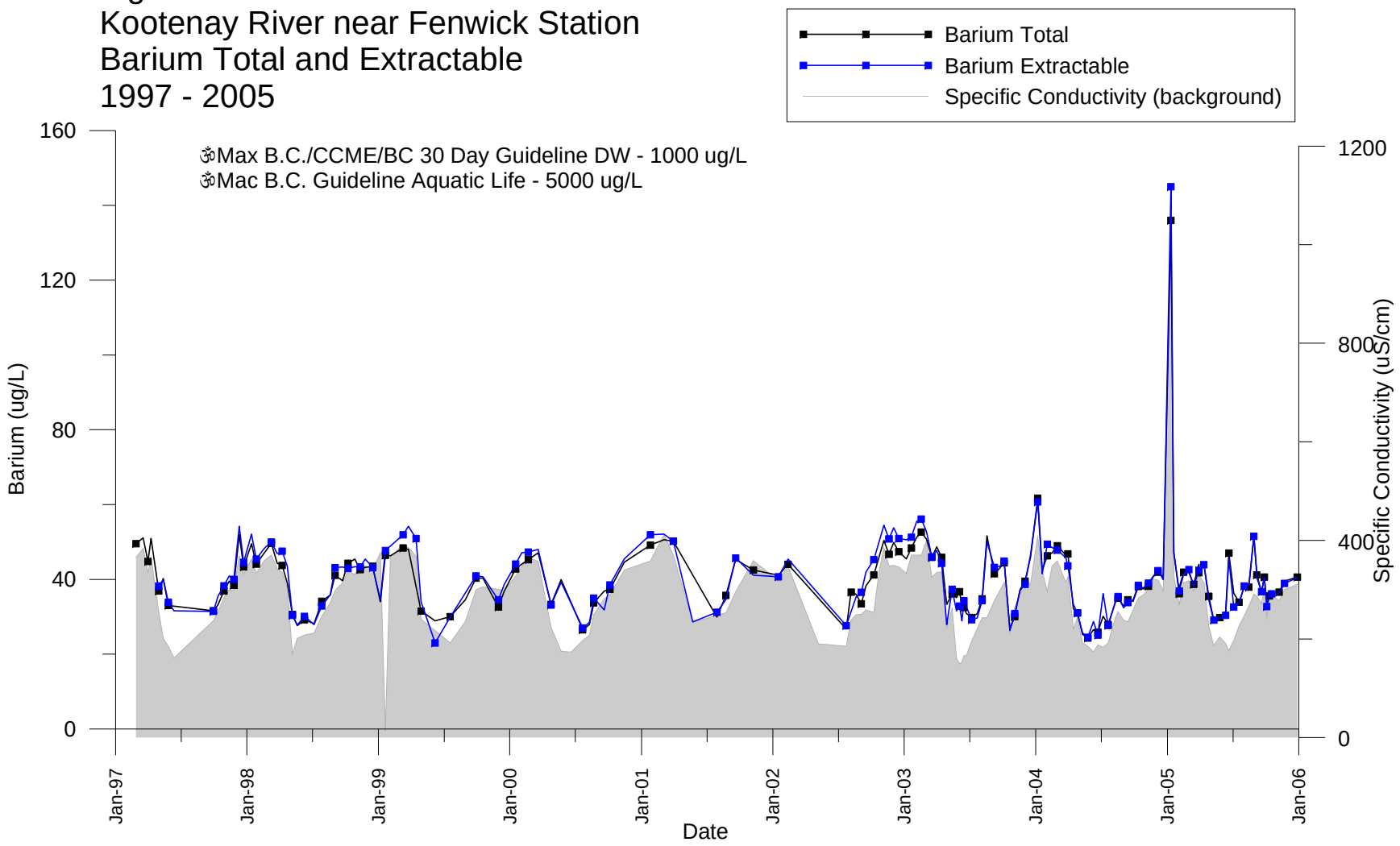

Figure 15
Kootenay River near Fenwick Station
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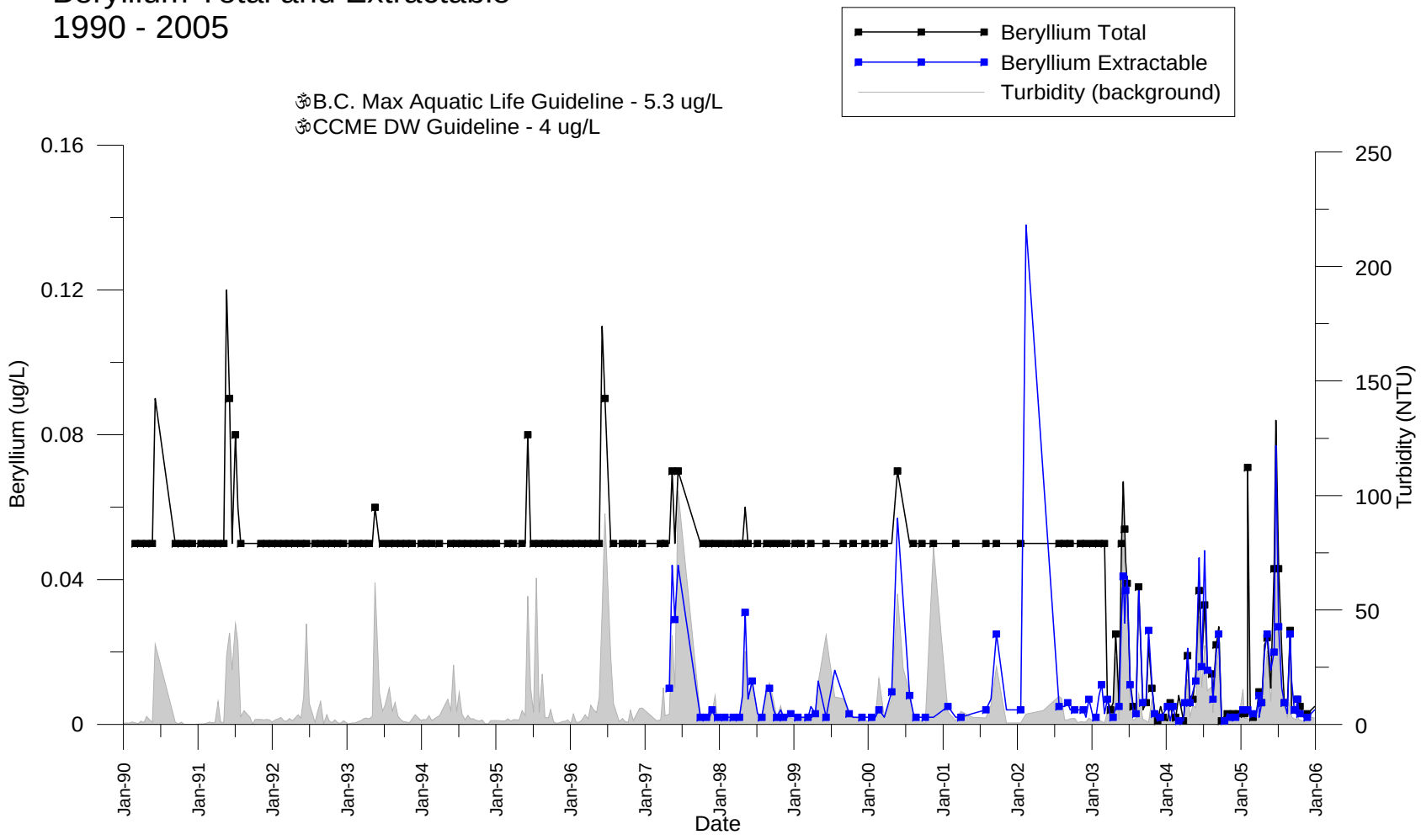

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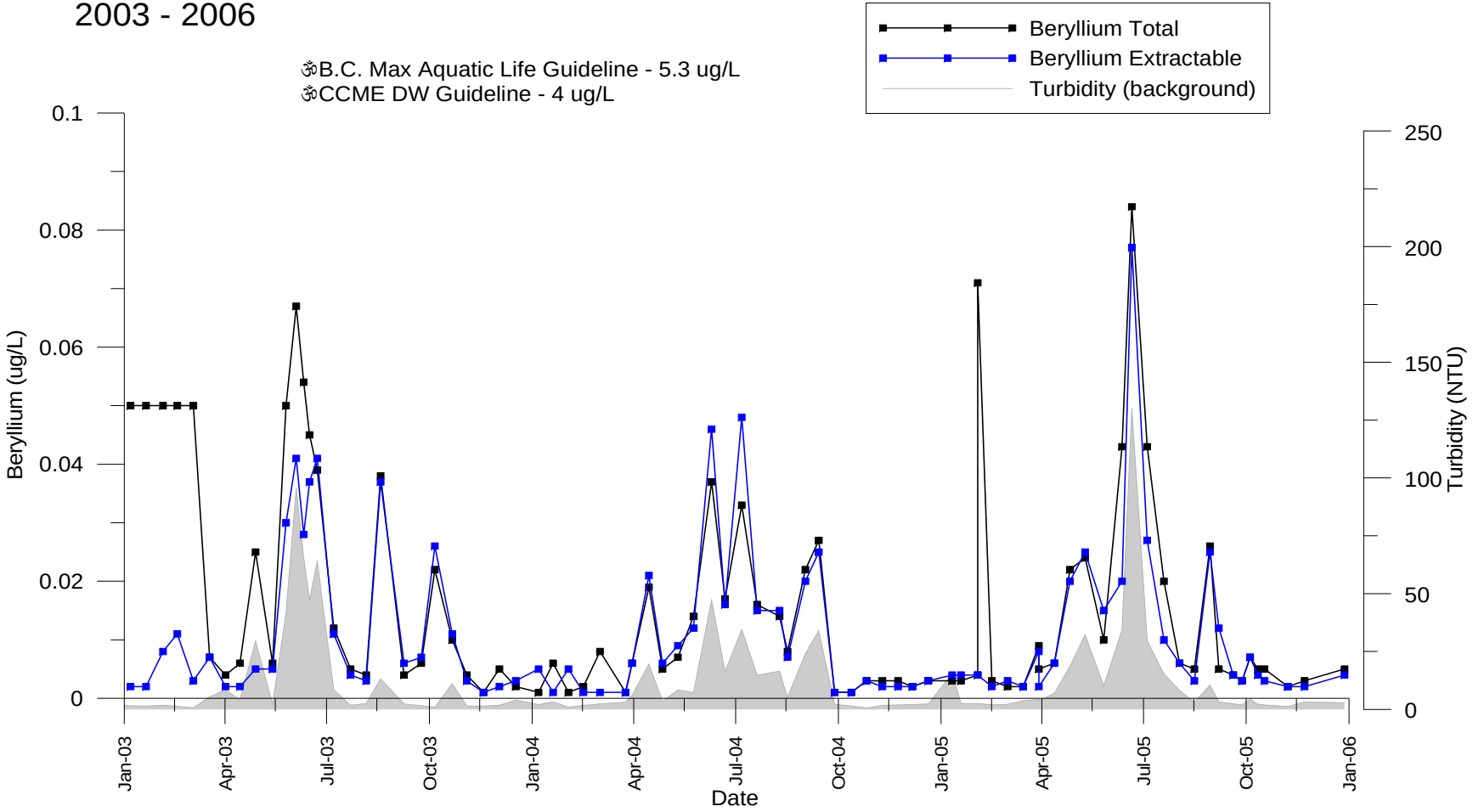

Figure 17
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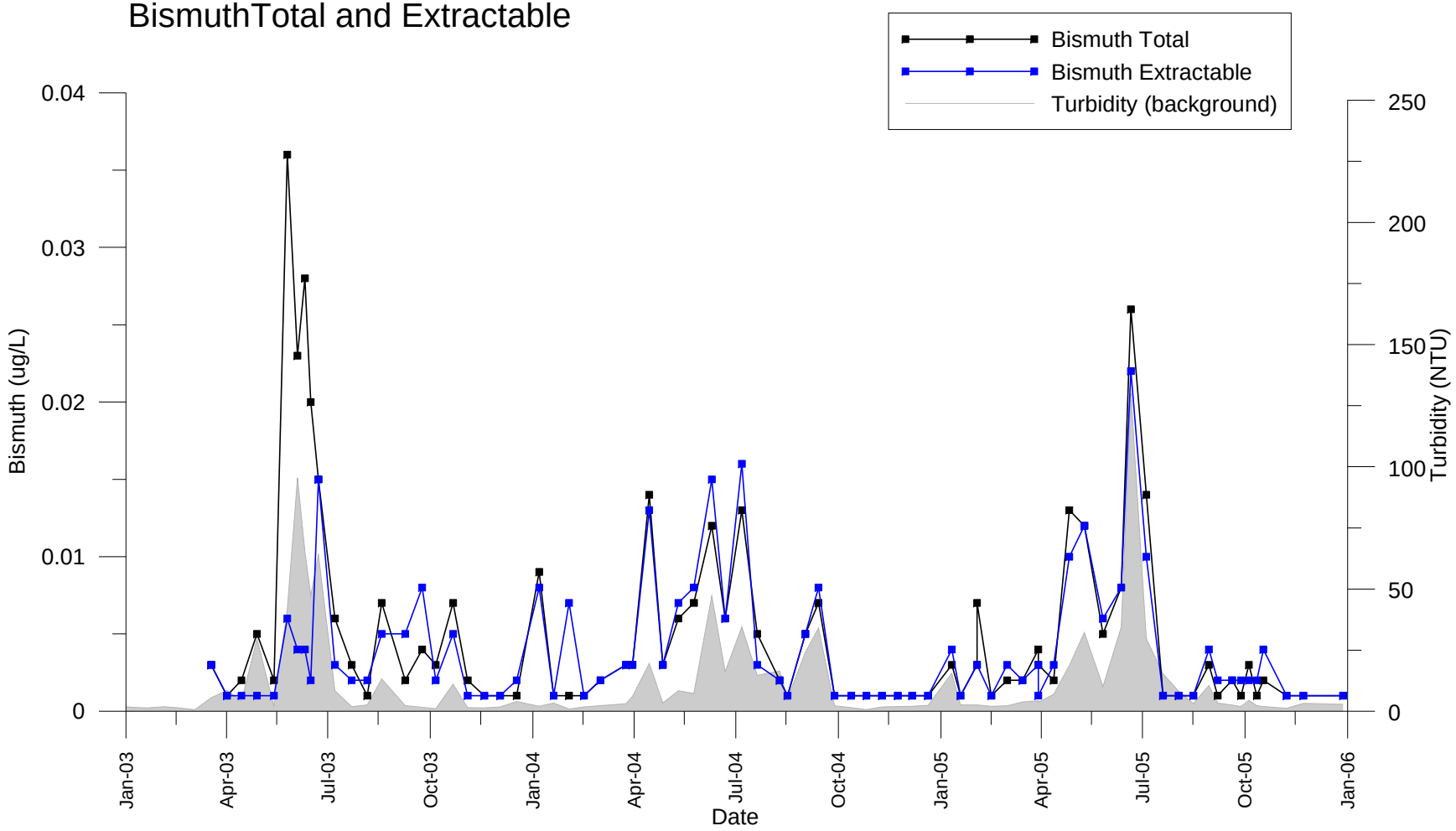

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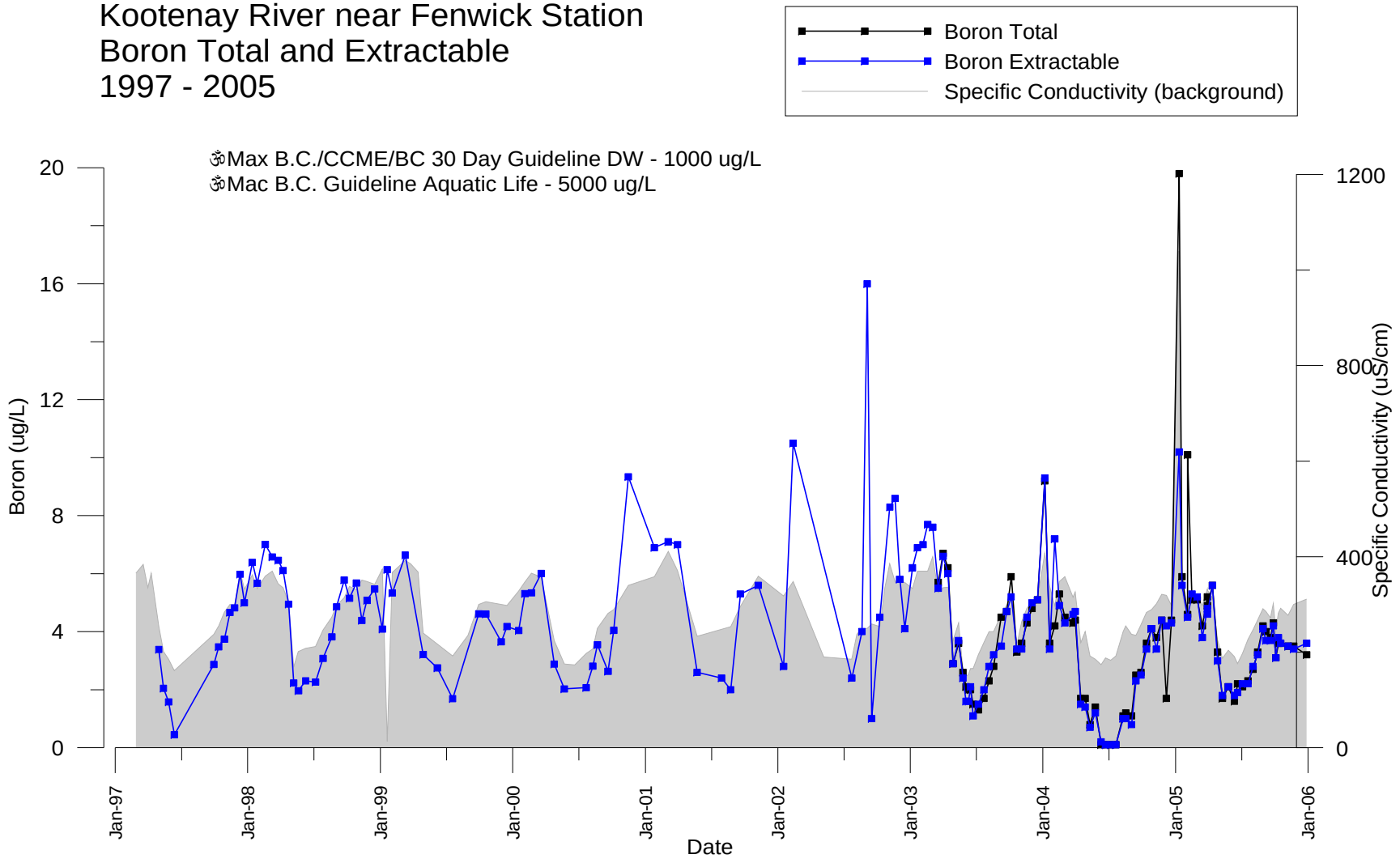

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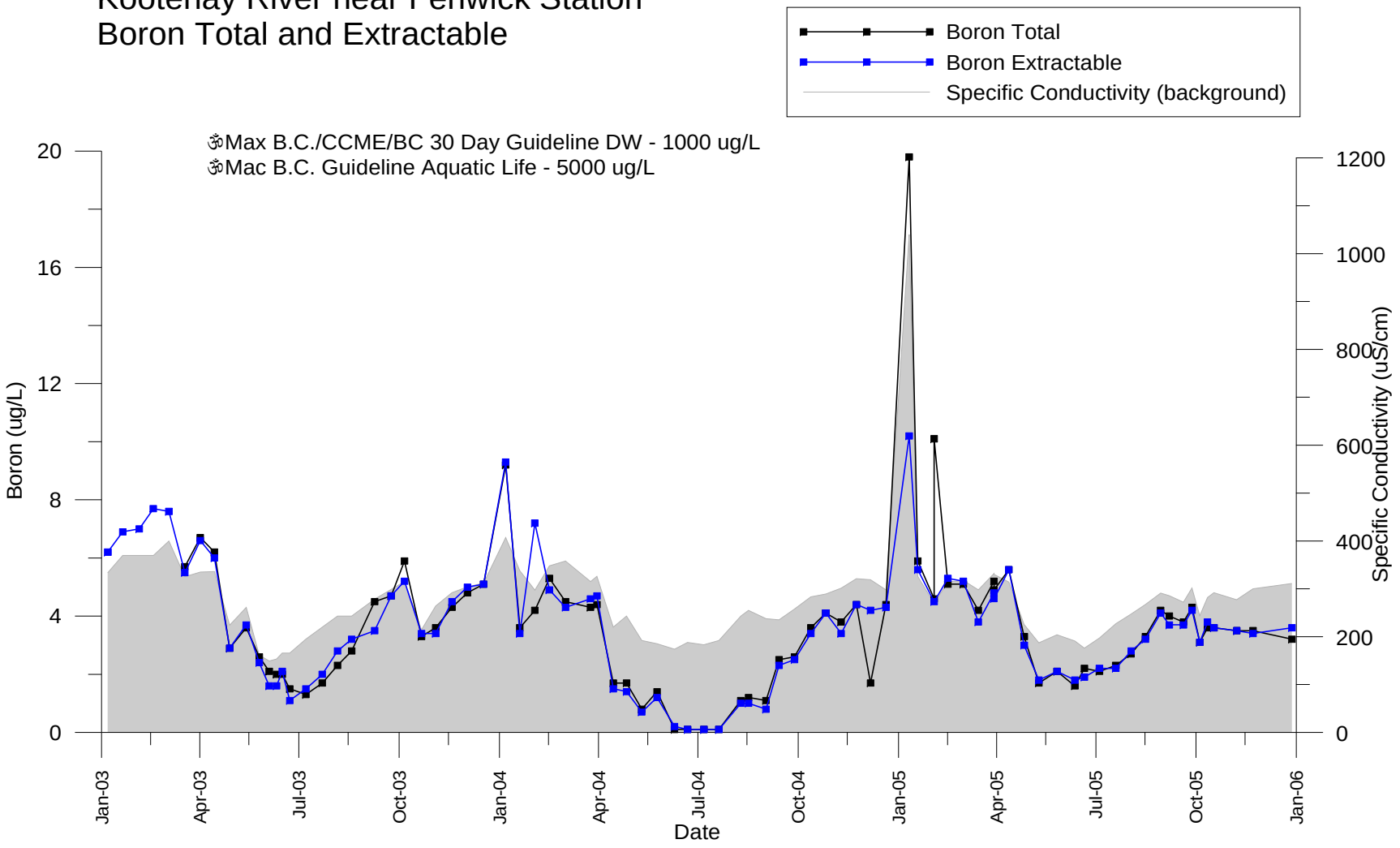

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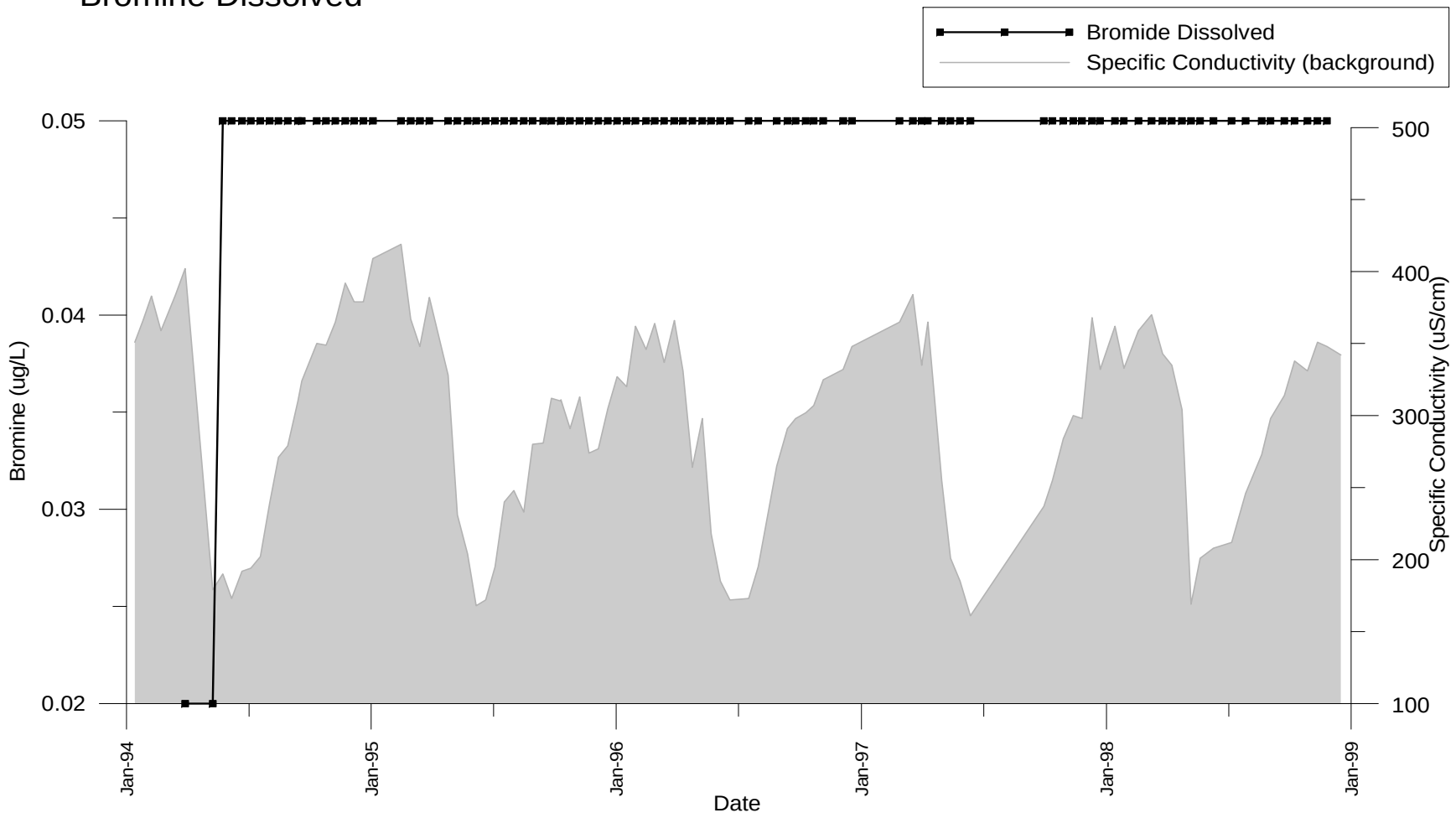

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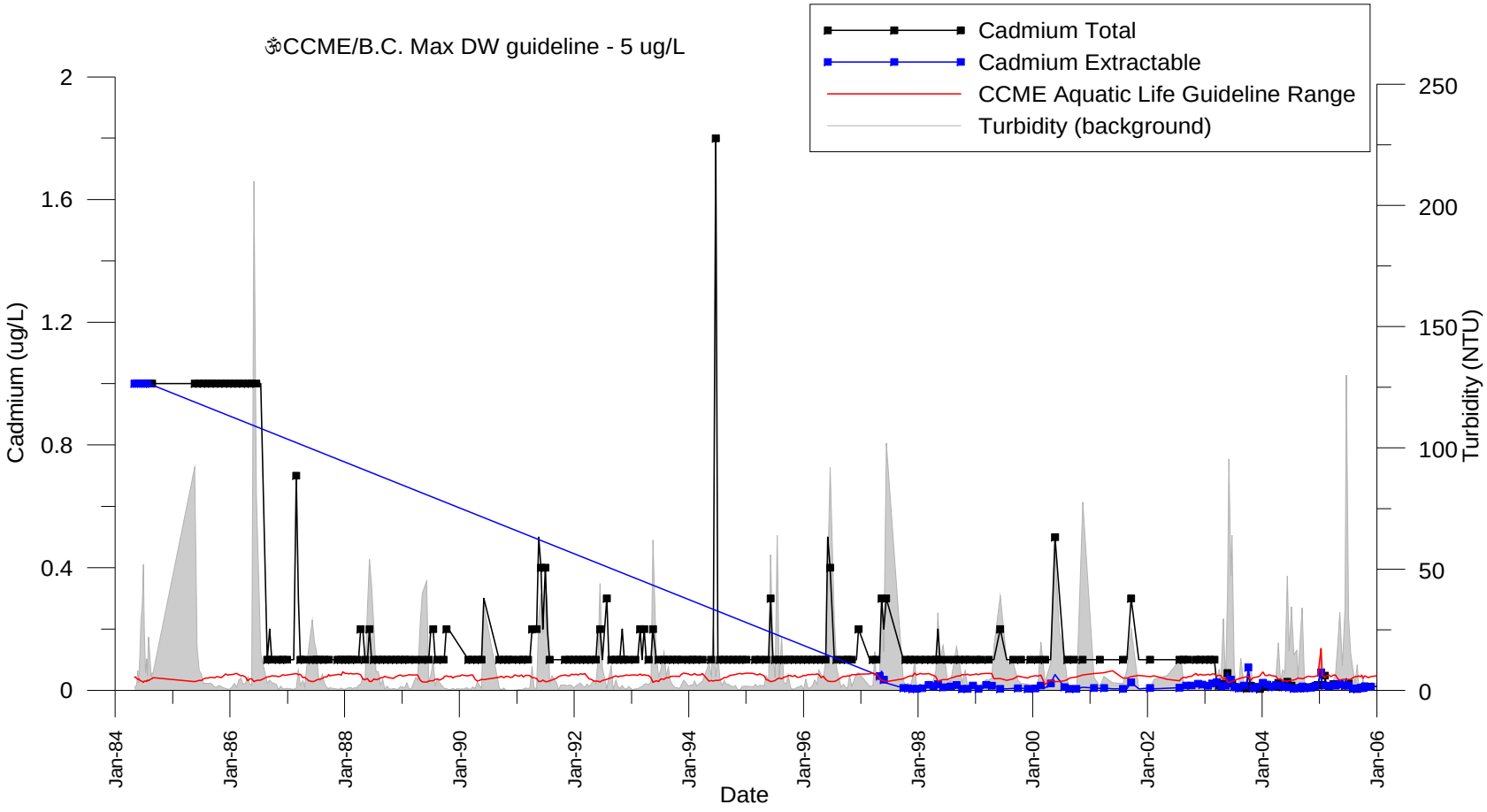
1984 - 2005



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Kootenay River near Fenwick Station
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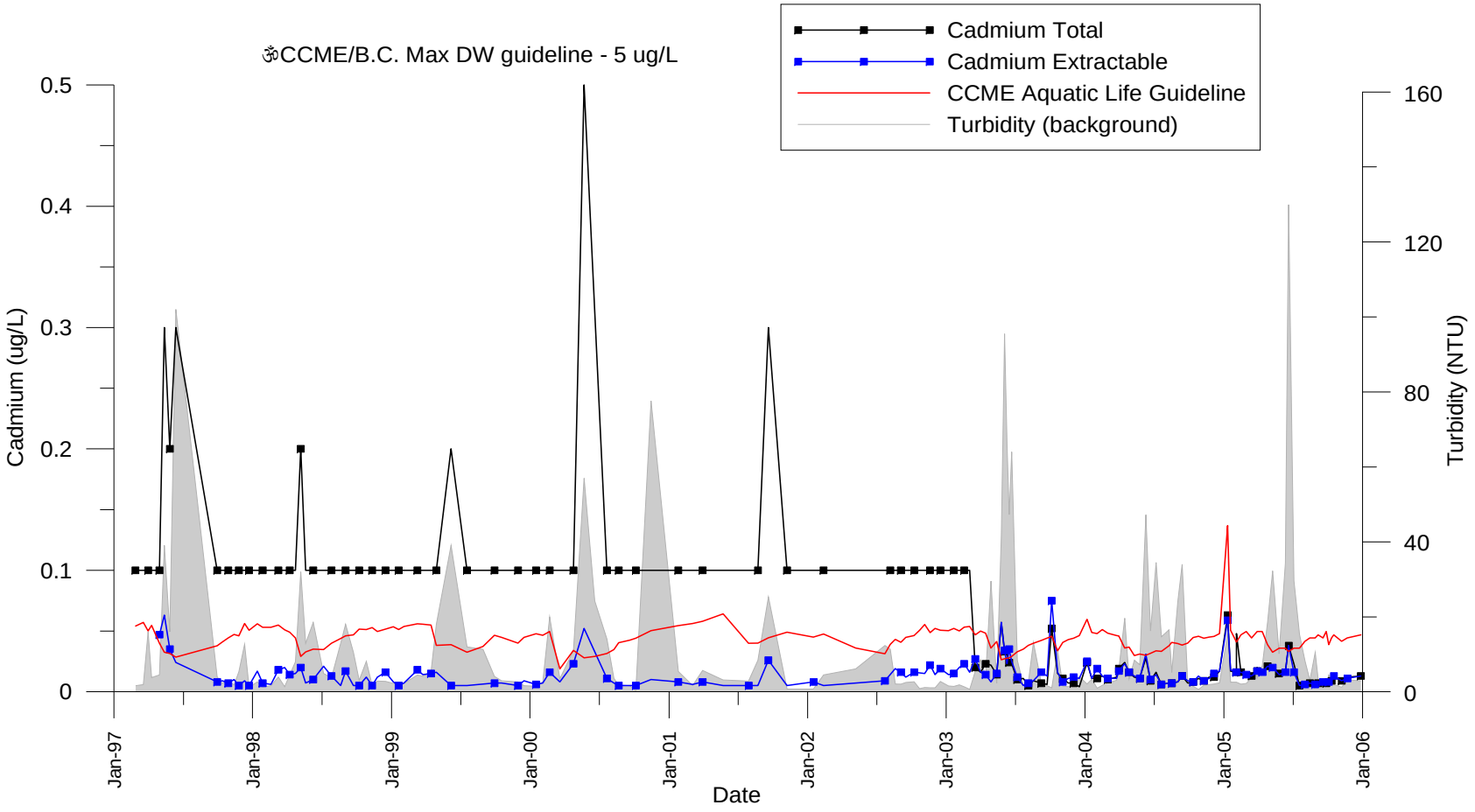

Figure 23
Kootenay River near Fenwick Station
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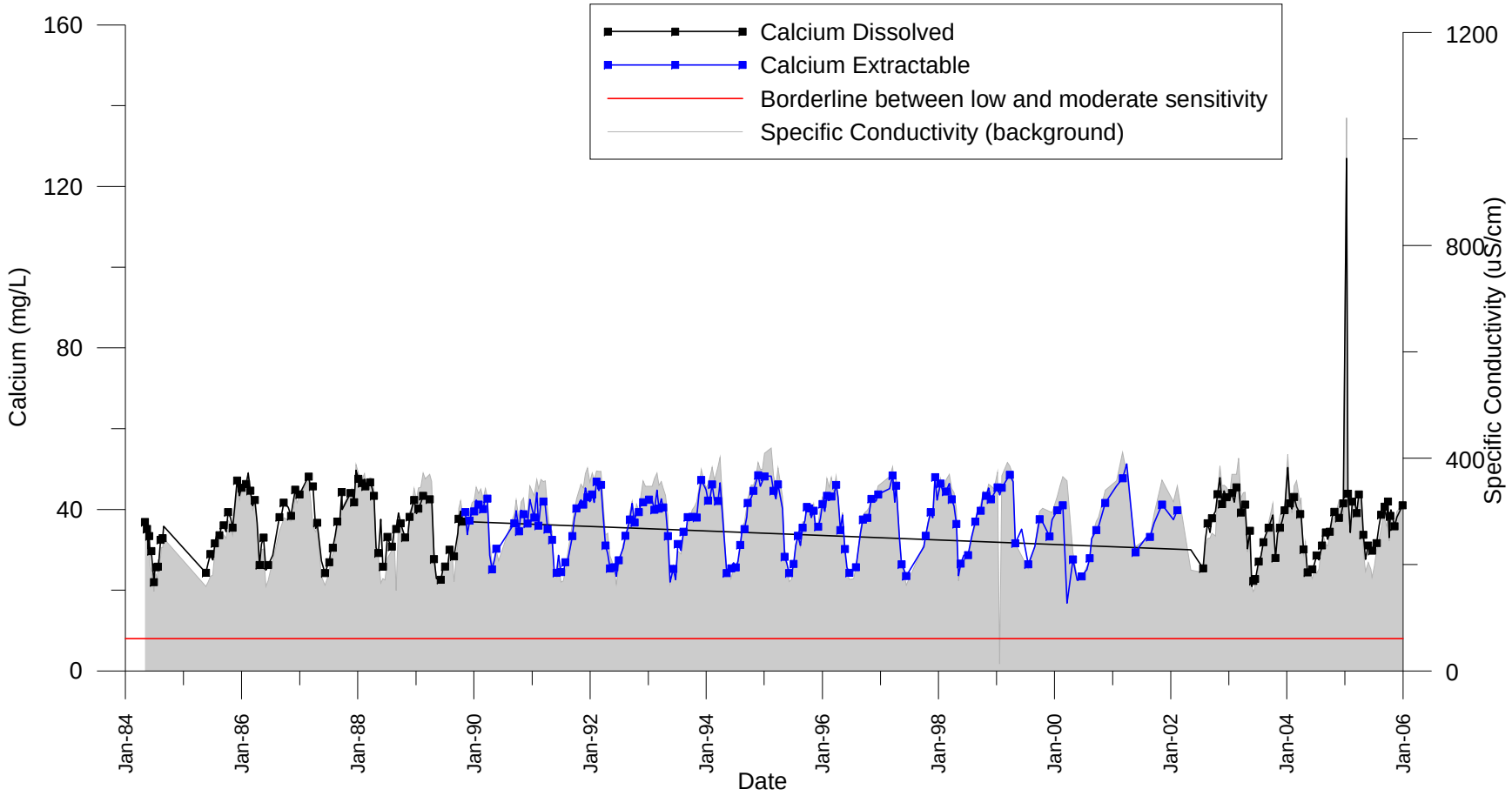

Figure 24
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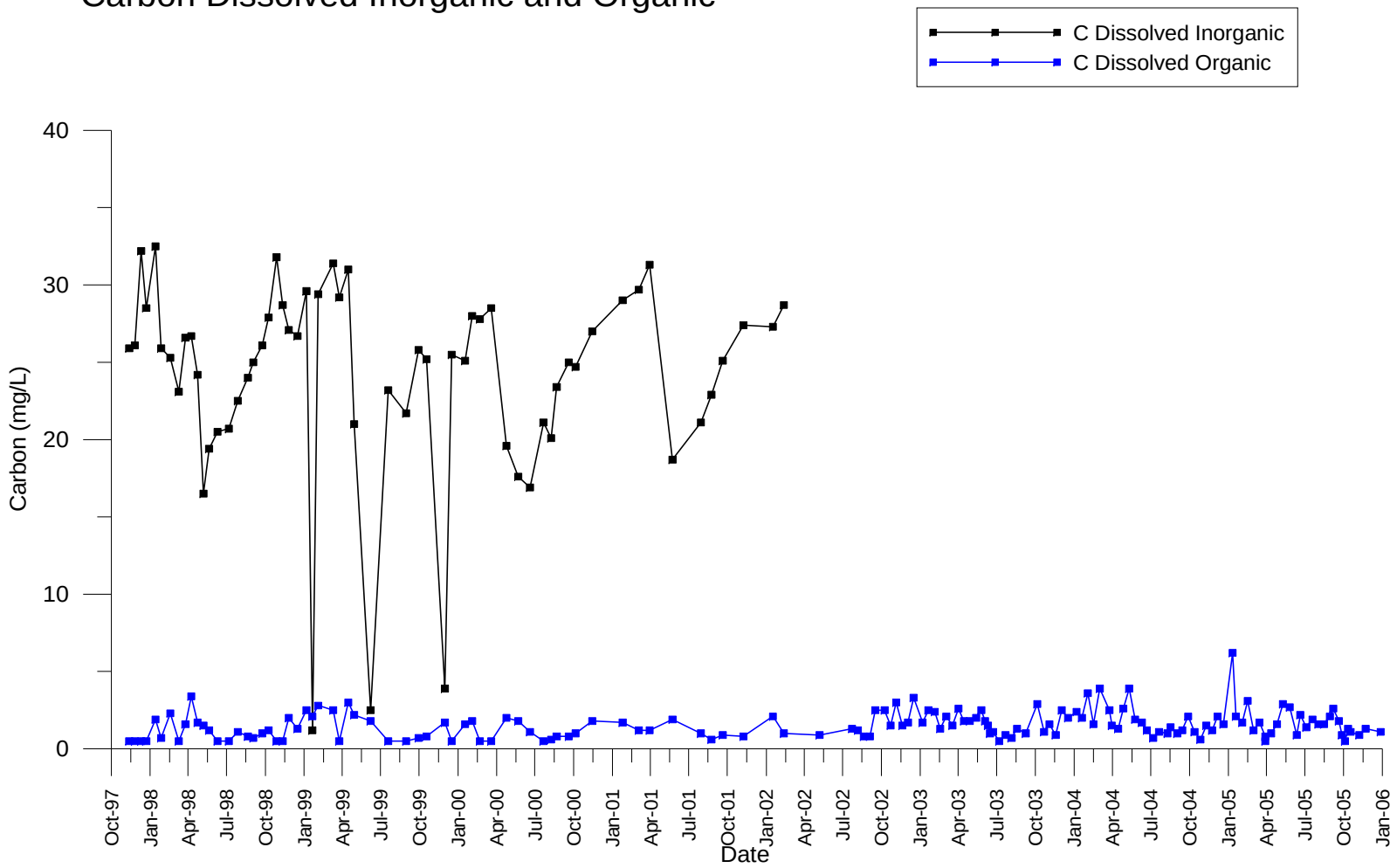

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Kootenay River near Fenwick Station
Carbon Dissolved Inorganic

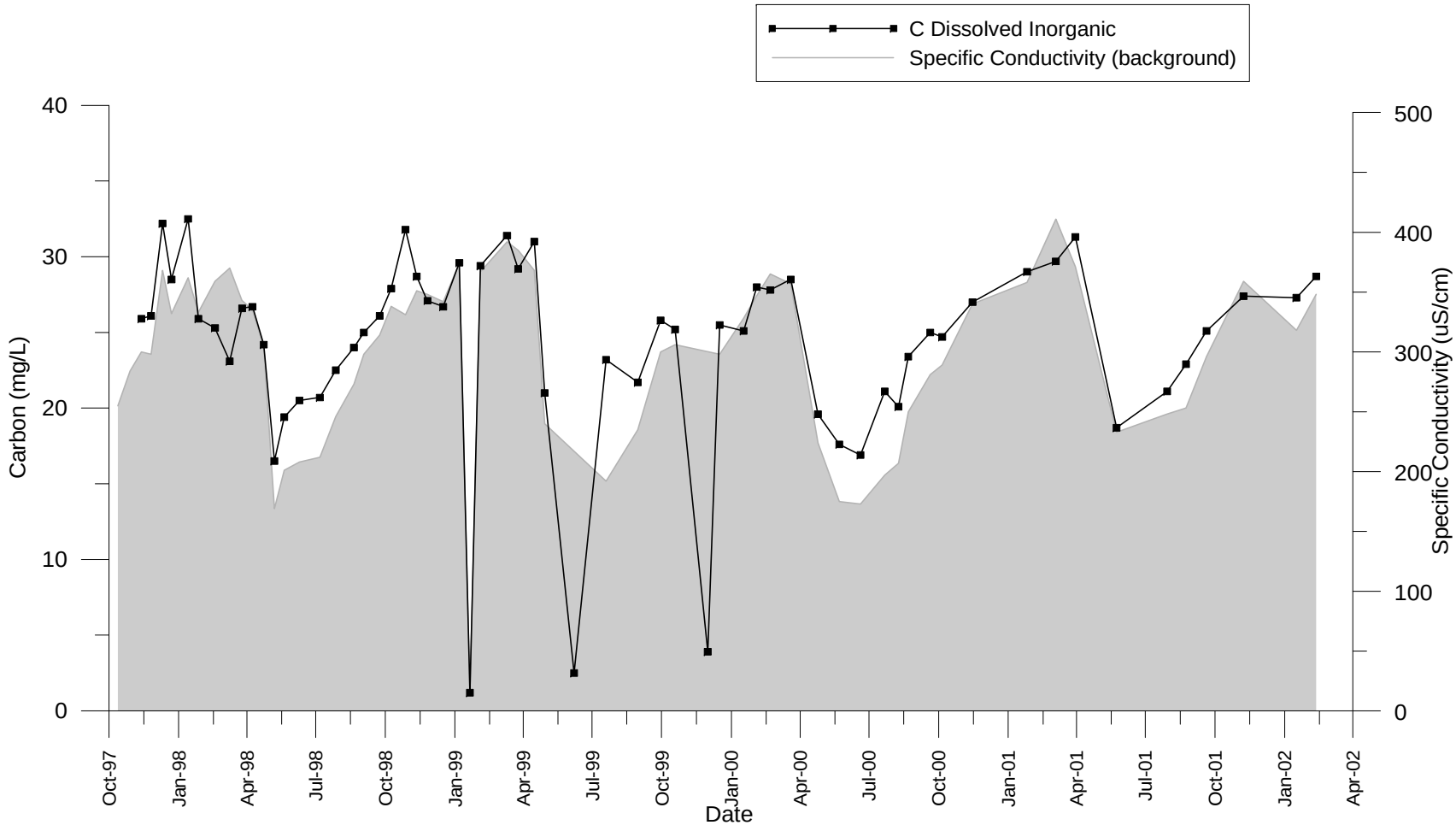

Figure 26
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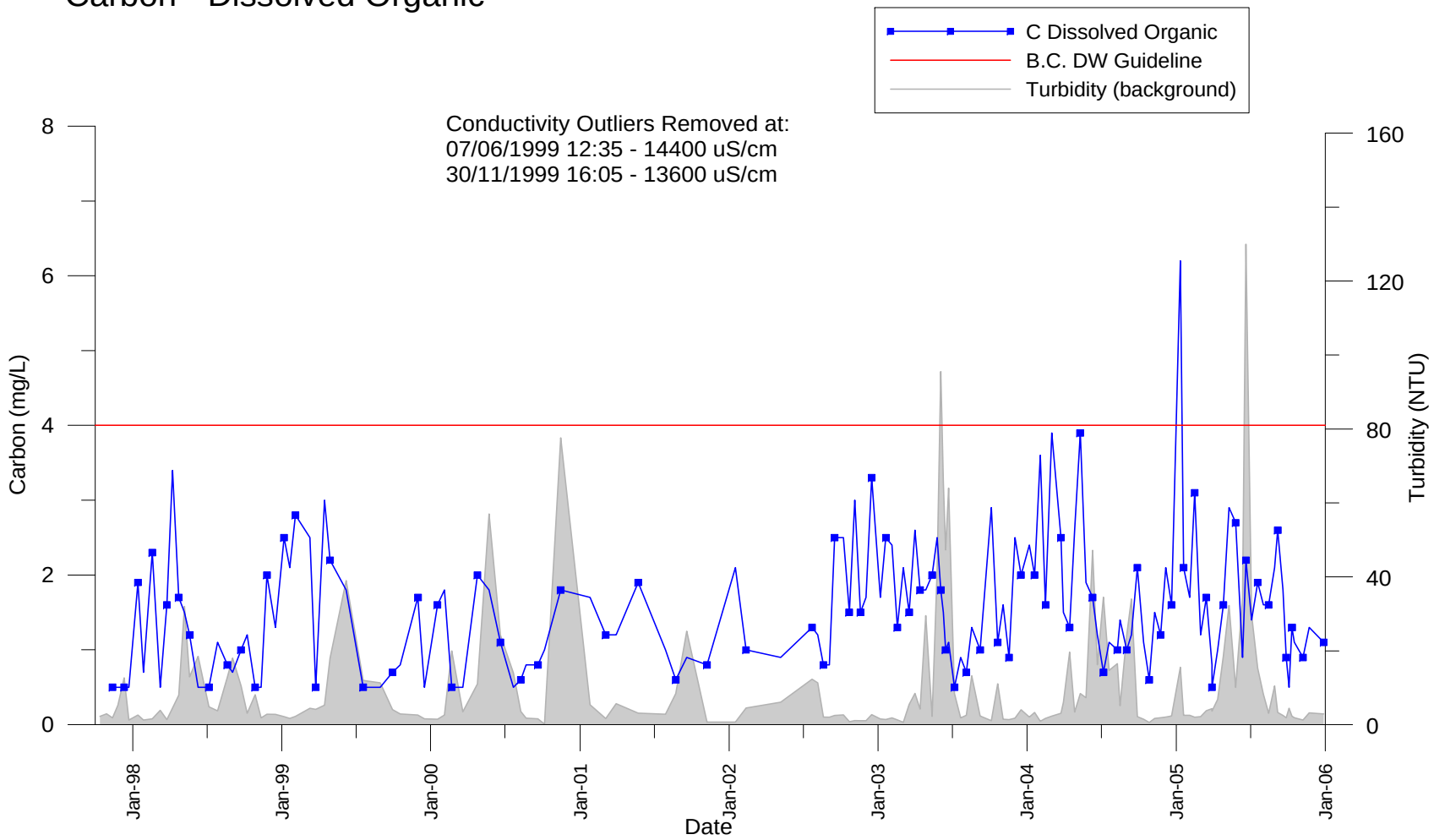
Carbon - Dissolved Organic



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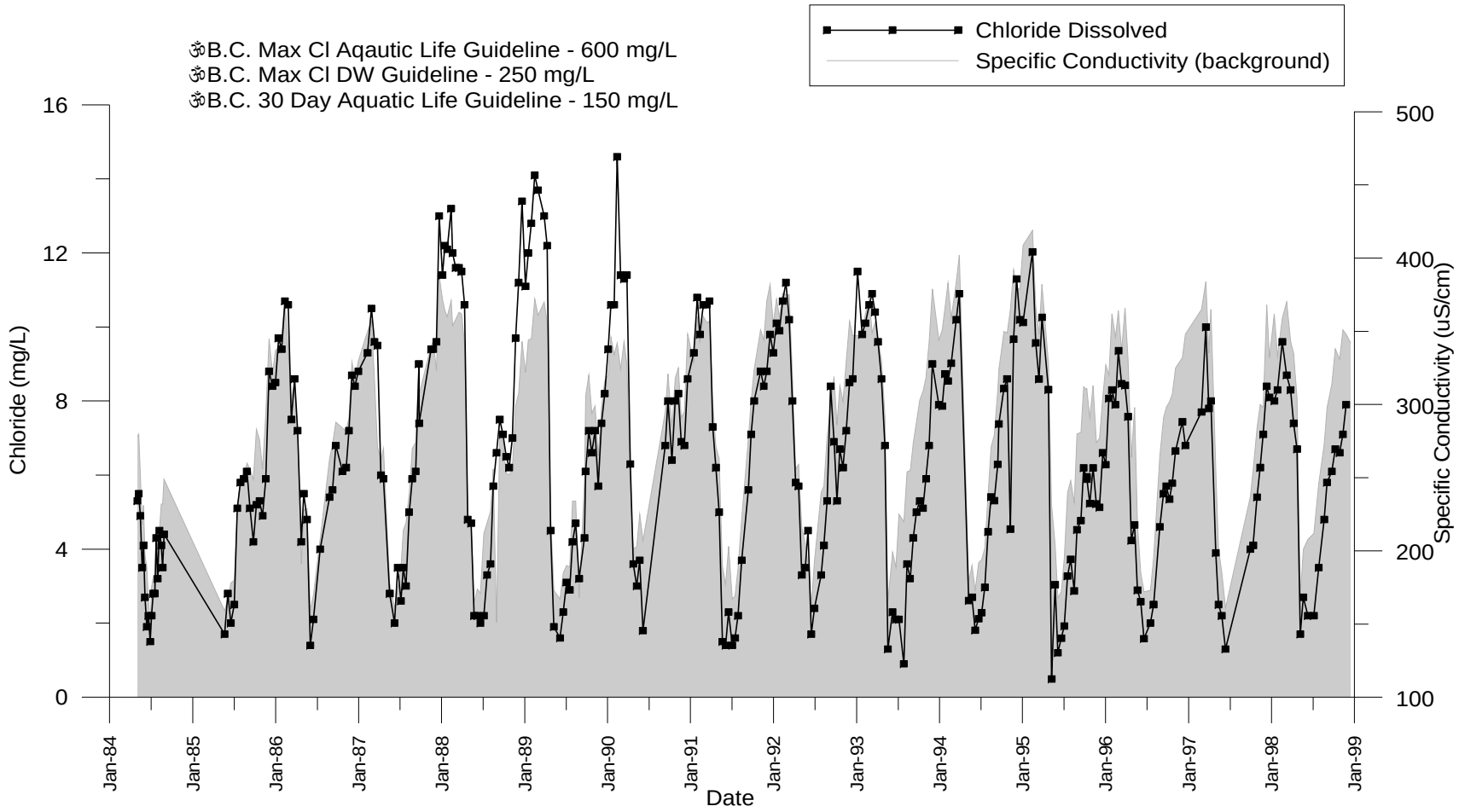
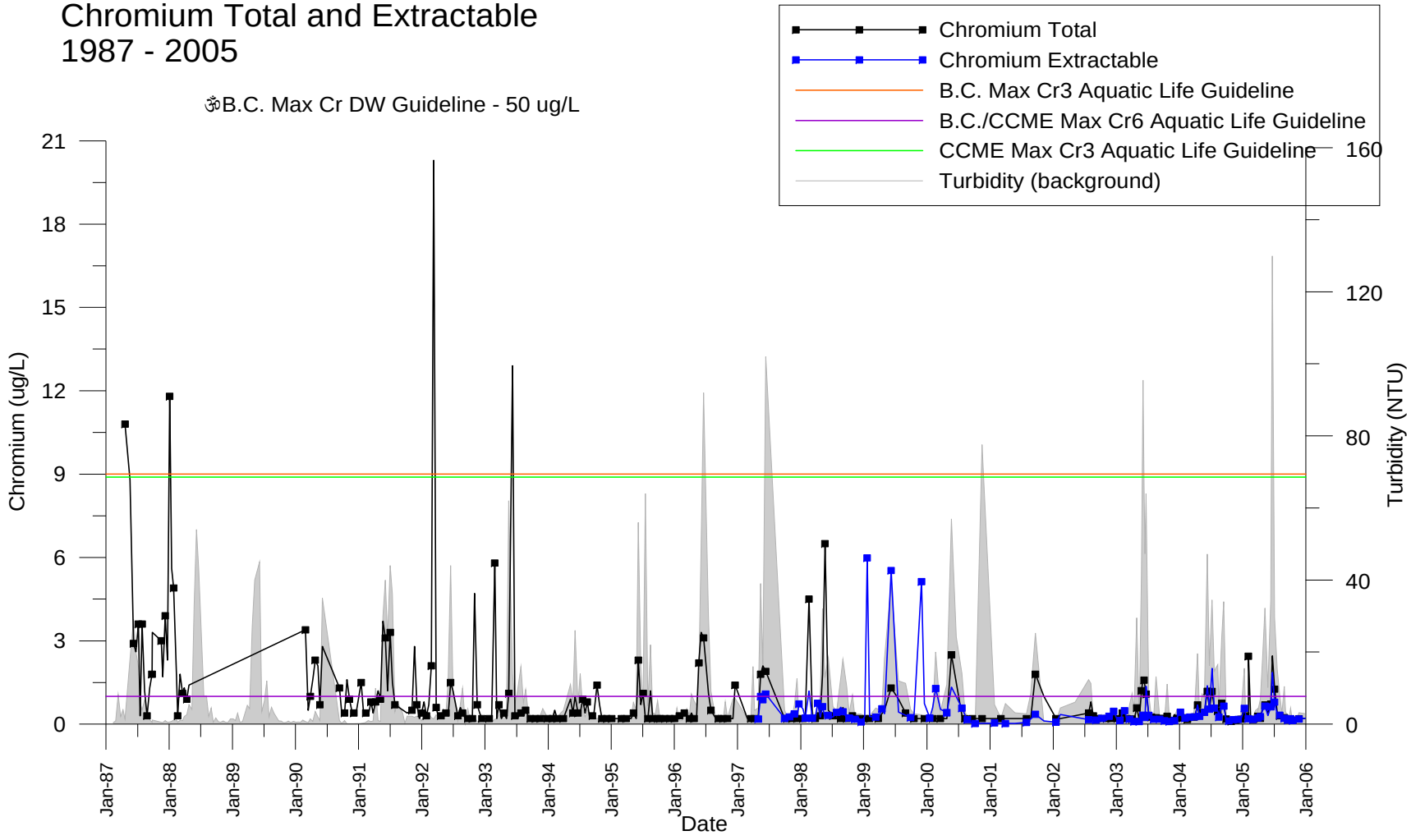


Figure 28
Kootenay River near Fenwick Station
Chromium Total and Extractable
1987 - 2005



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Kootenay River near Fenwick Station
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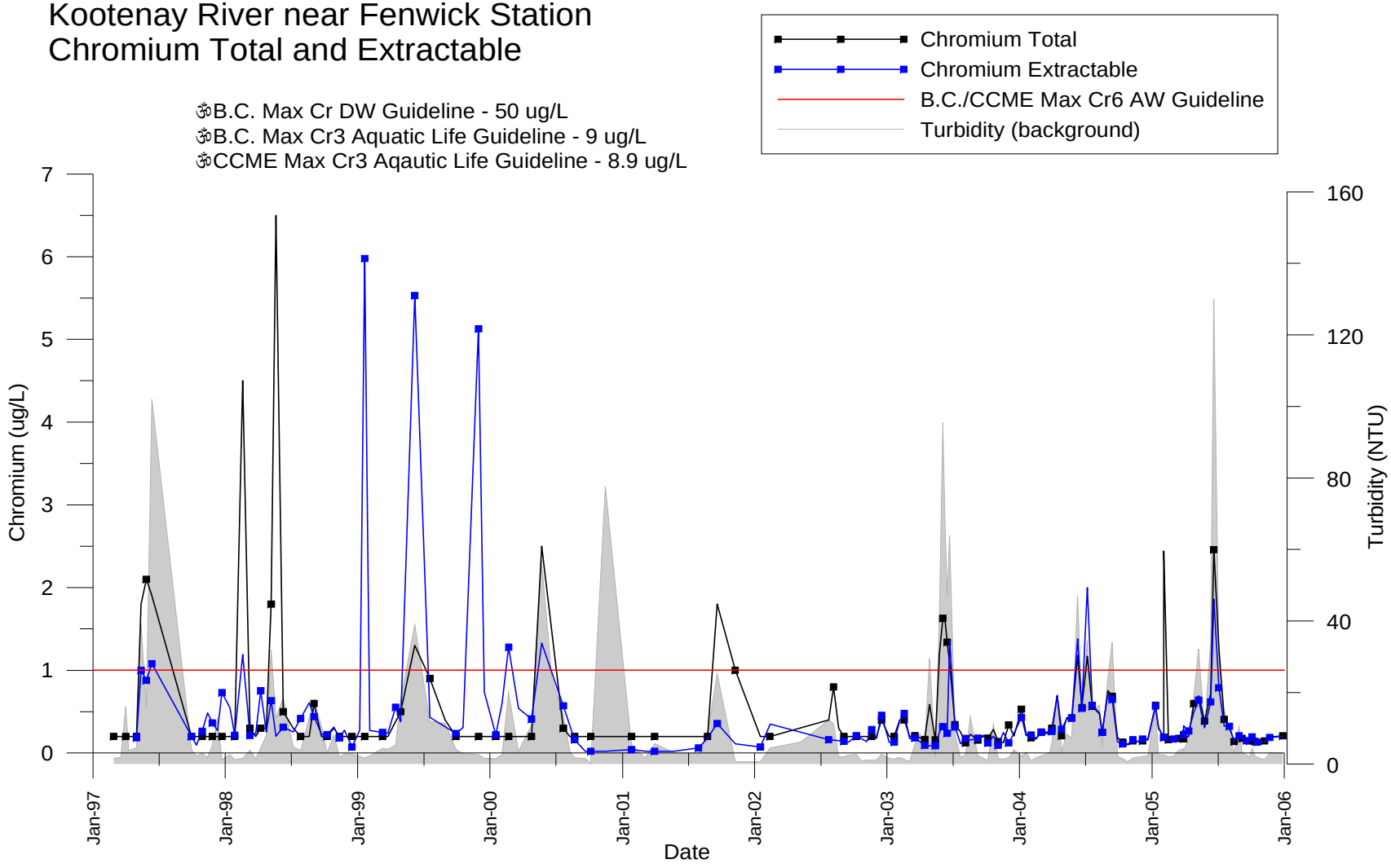

Figure 30
Kootenay River near Fenwick Station
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1990 - 2005

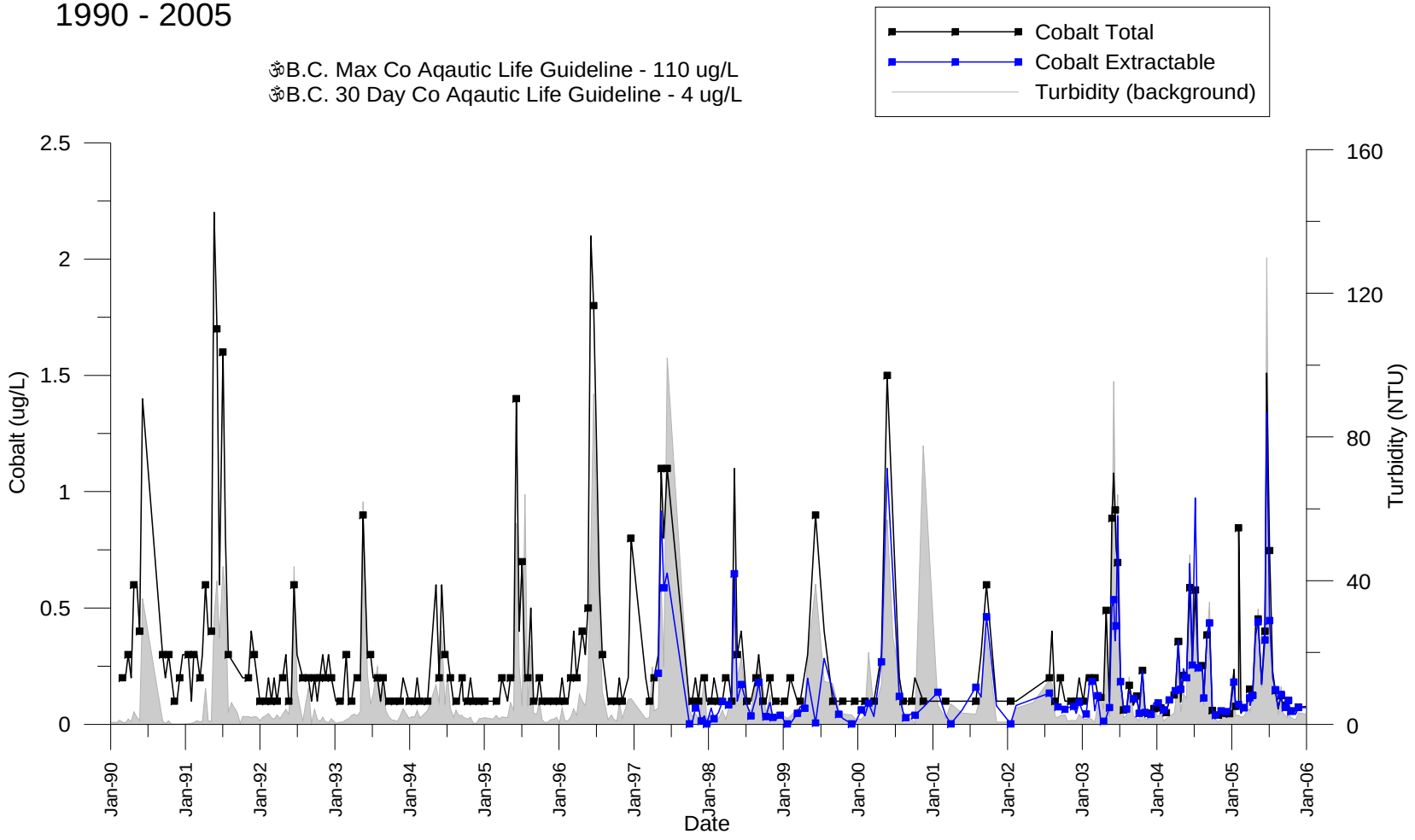

Figure 31
Kootenay River near Fenwick Station
Cobalt Total and Extractable

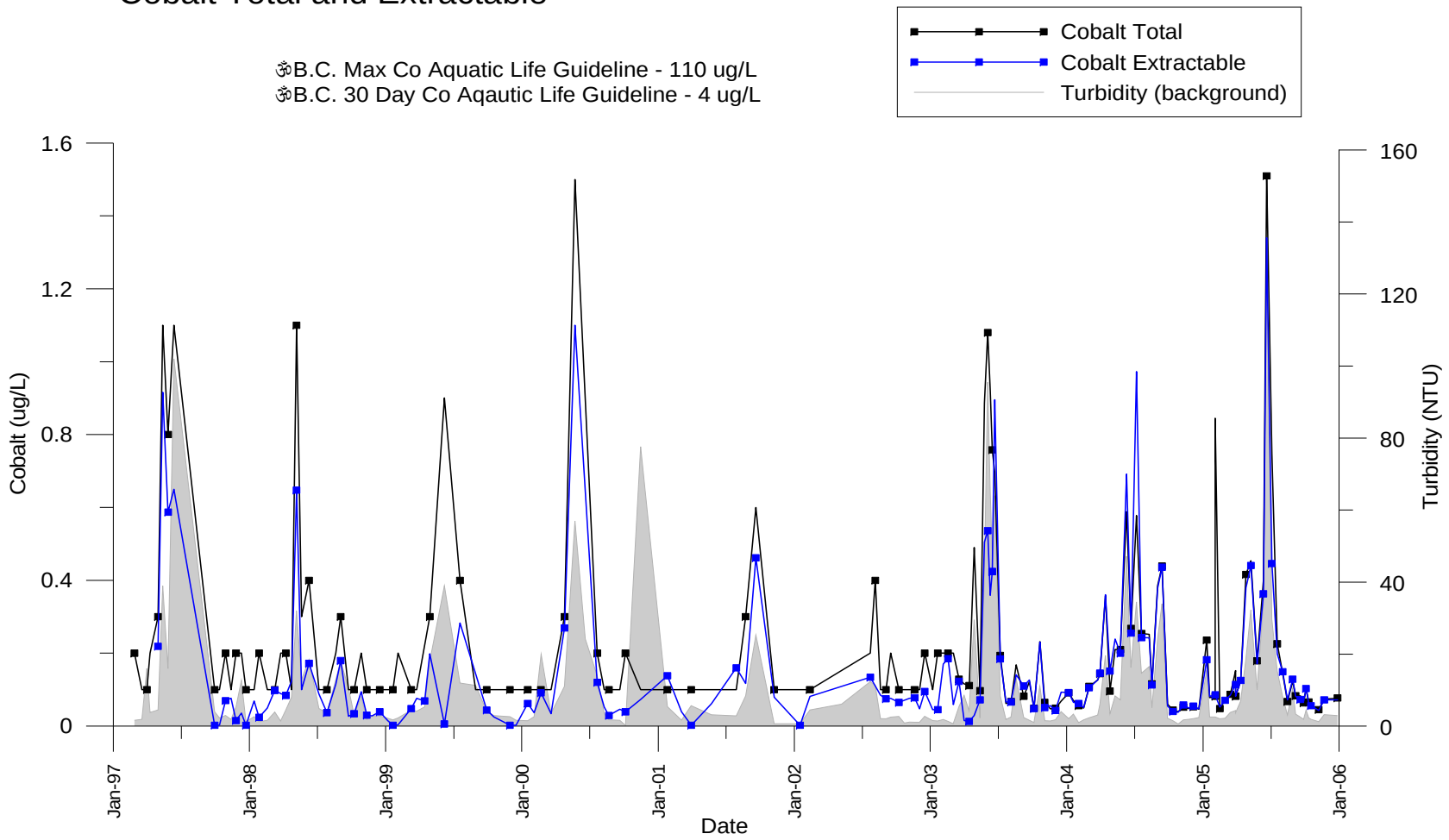

Figure 32
Kootenay River near Fenwick Station
Fecal Coliforms

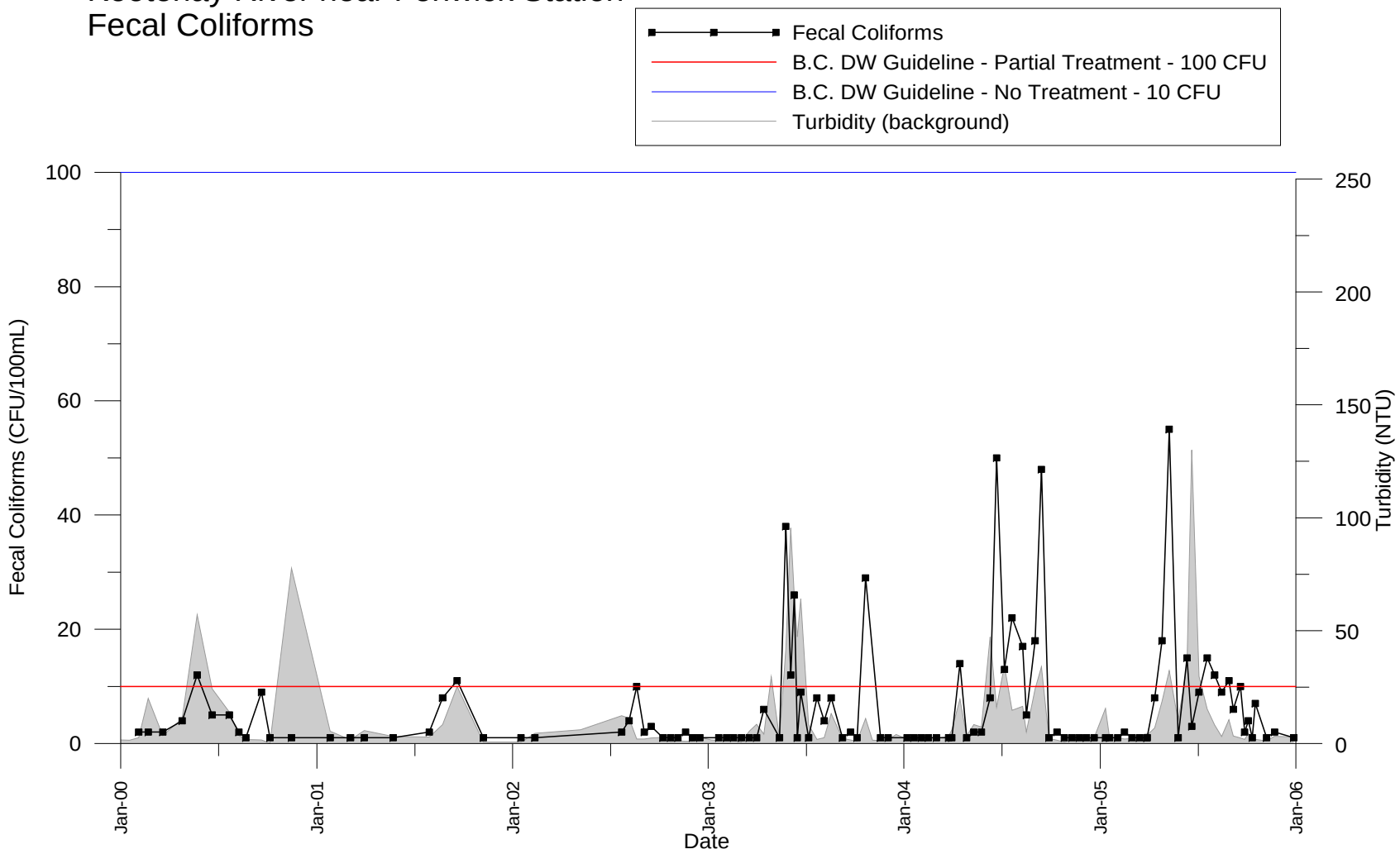

Figure 33
Kootenay River near Fenwick Station
Colour - Apparent

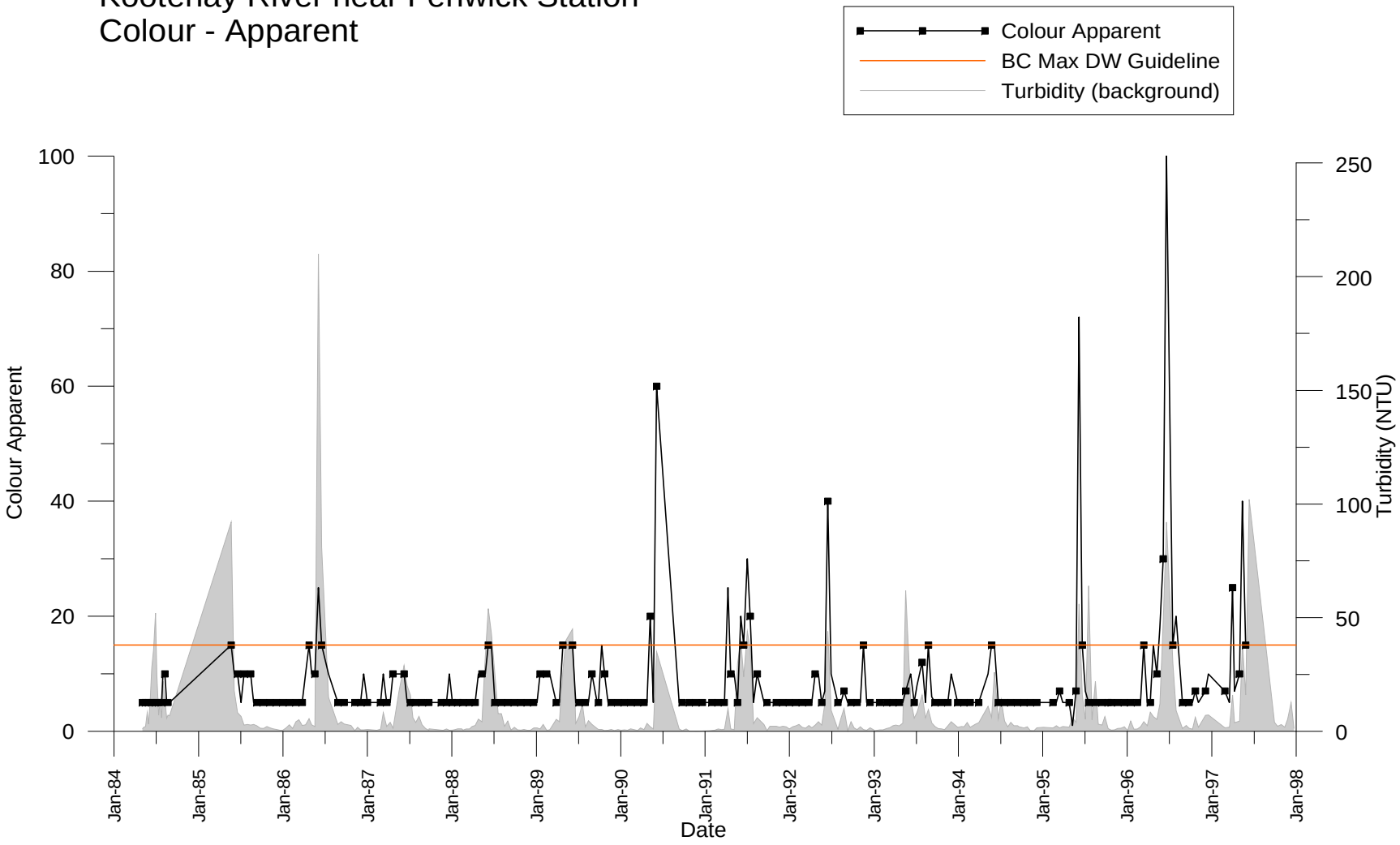

Figure 34
Kootenay River near Fenwick Station
Colour Single Wavelength

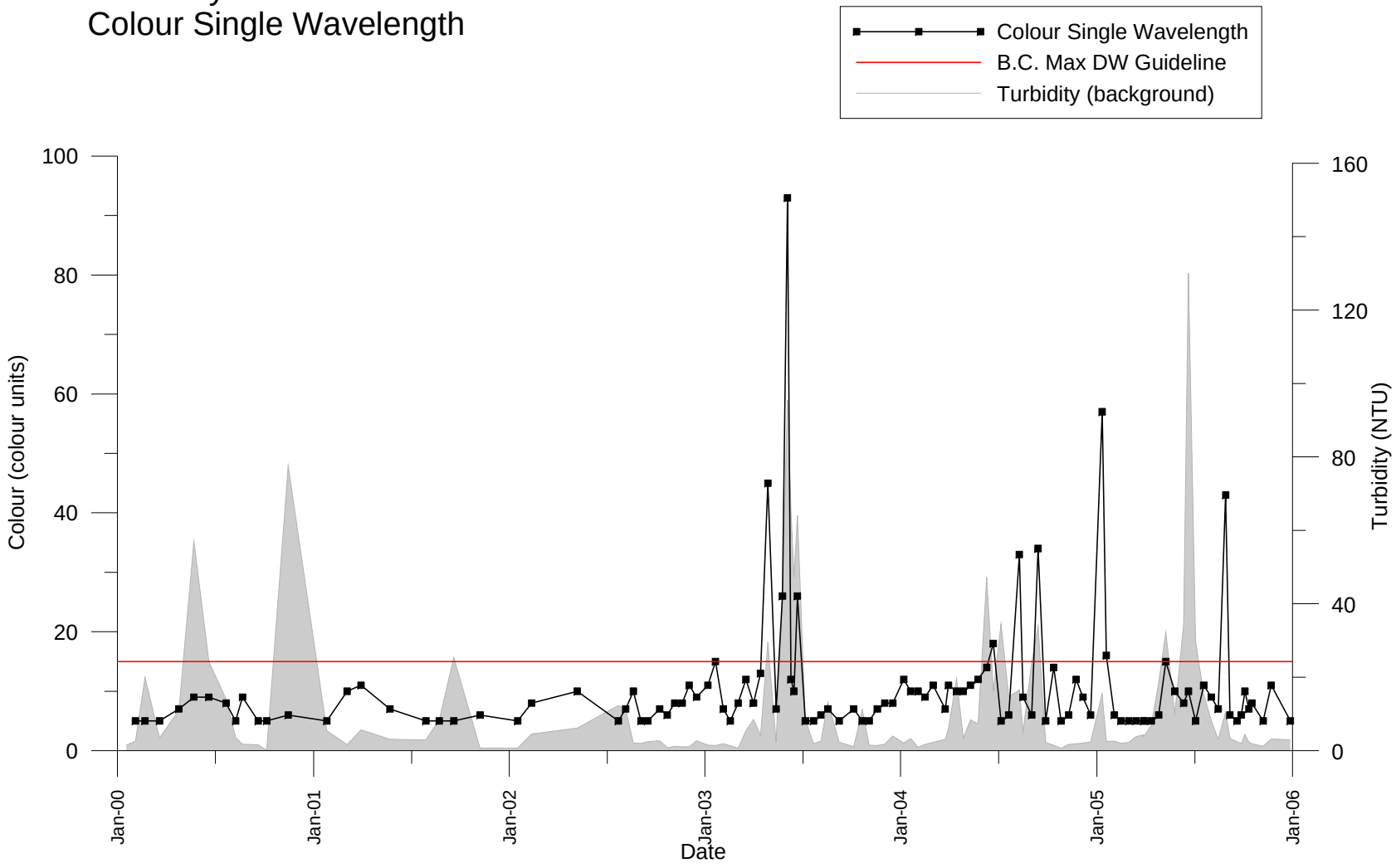

Figure 35
Kootenay River near Fenwick Station
Colour True

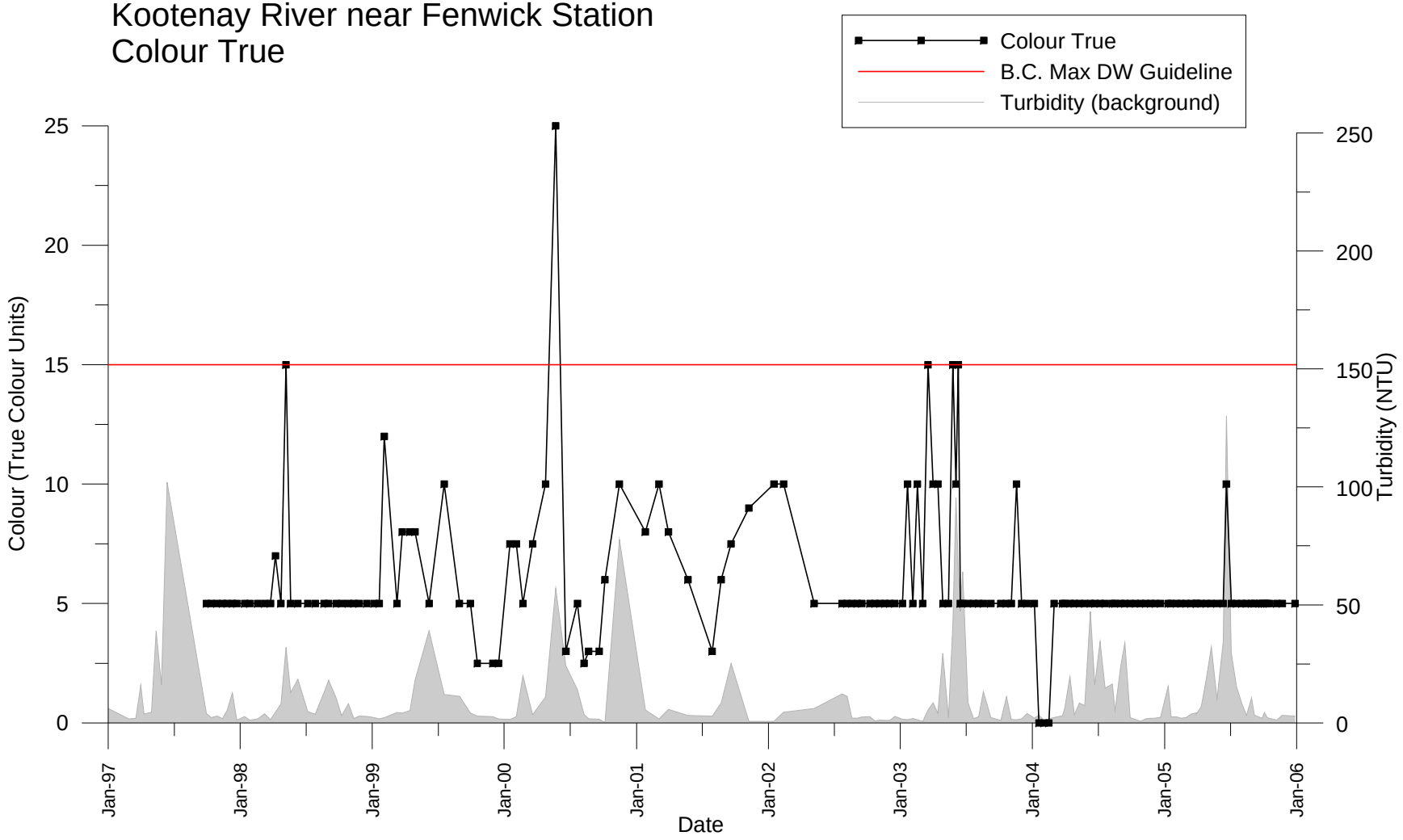

Figure 36
Kootenay River near Fenwick Station
Copper Total and Extractable
1984 - 2006

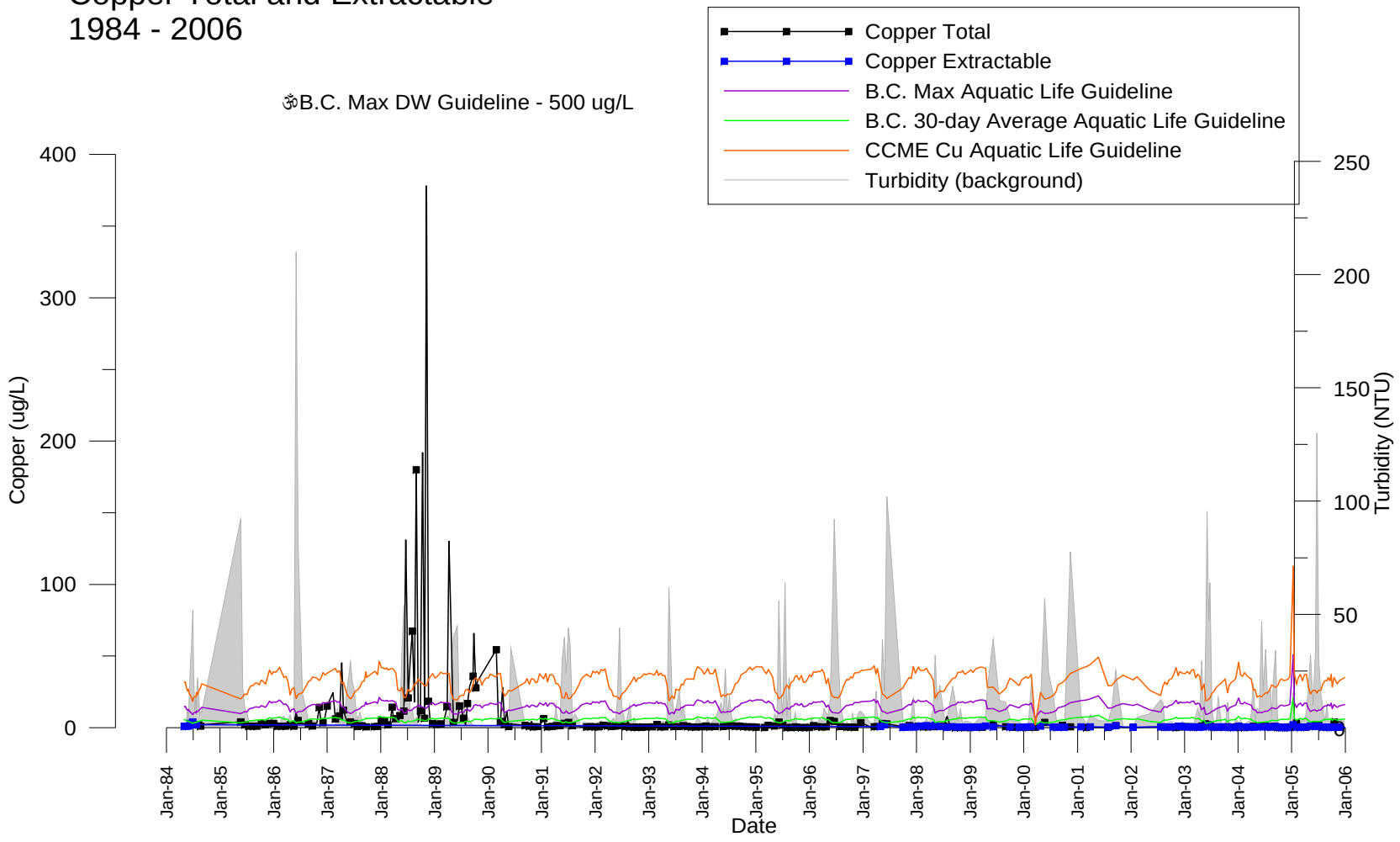

Figure 37
Kootenay River near Fenwick Station
Copper Total and Extractable
1997 - 2006

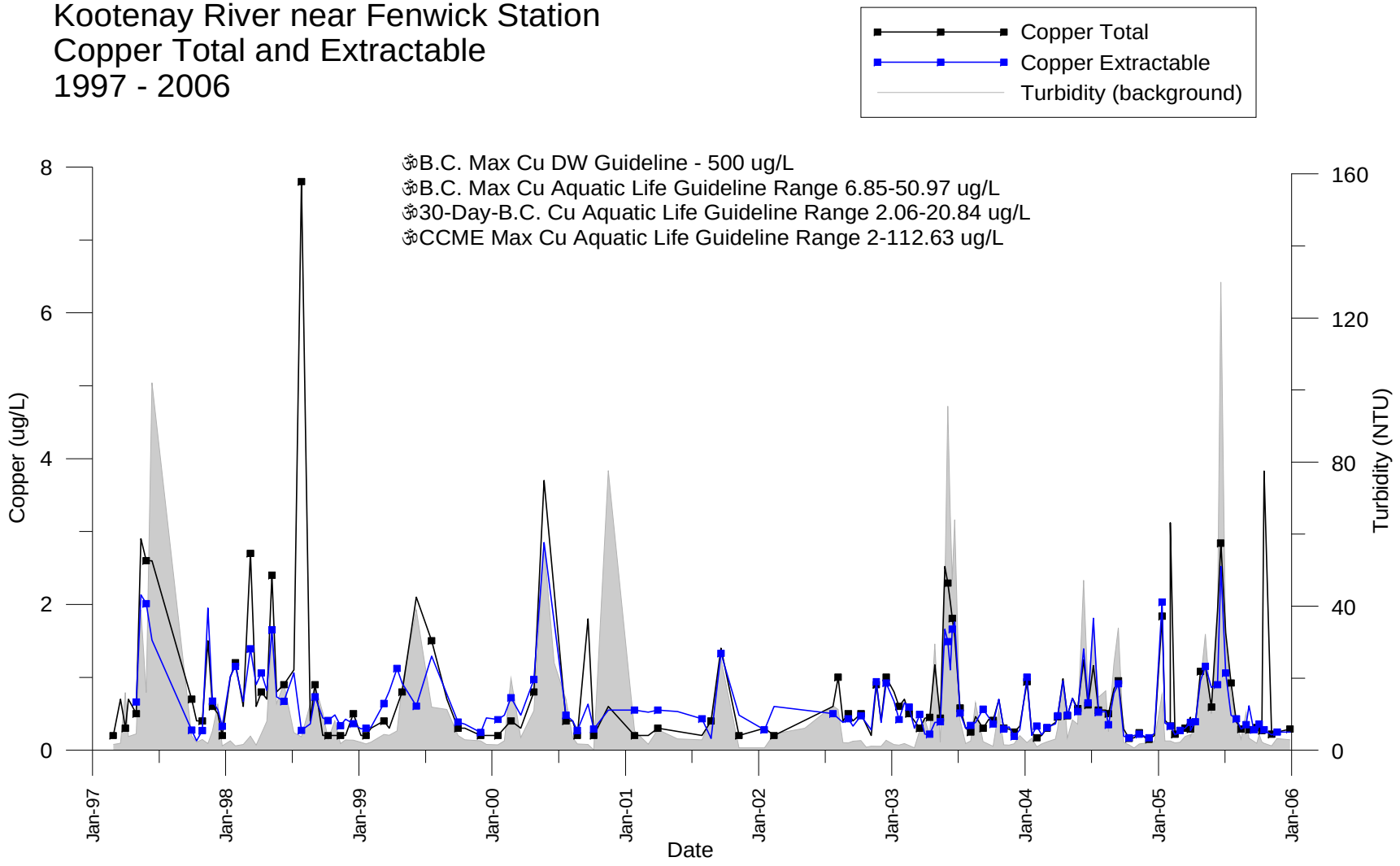

Figure 38
Kootenay River near Fenwick Station
Fluoride - Dissolved and Total
1984 - 1999

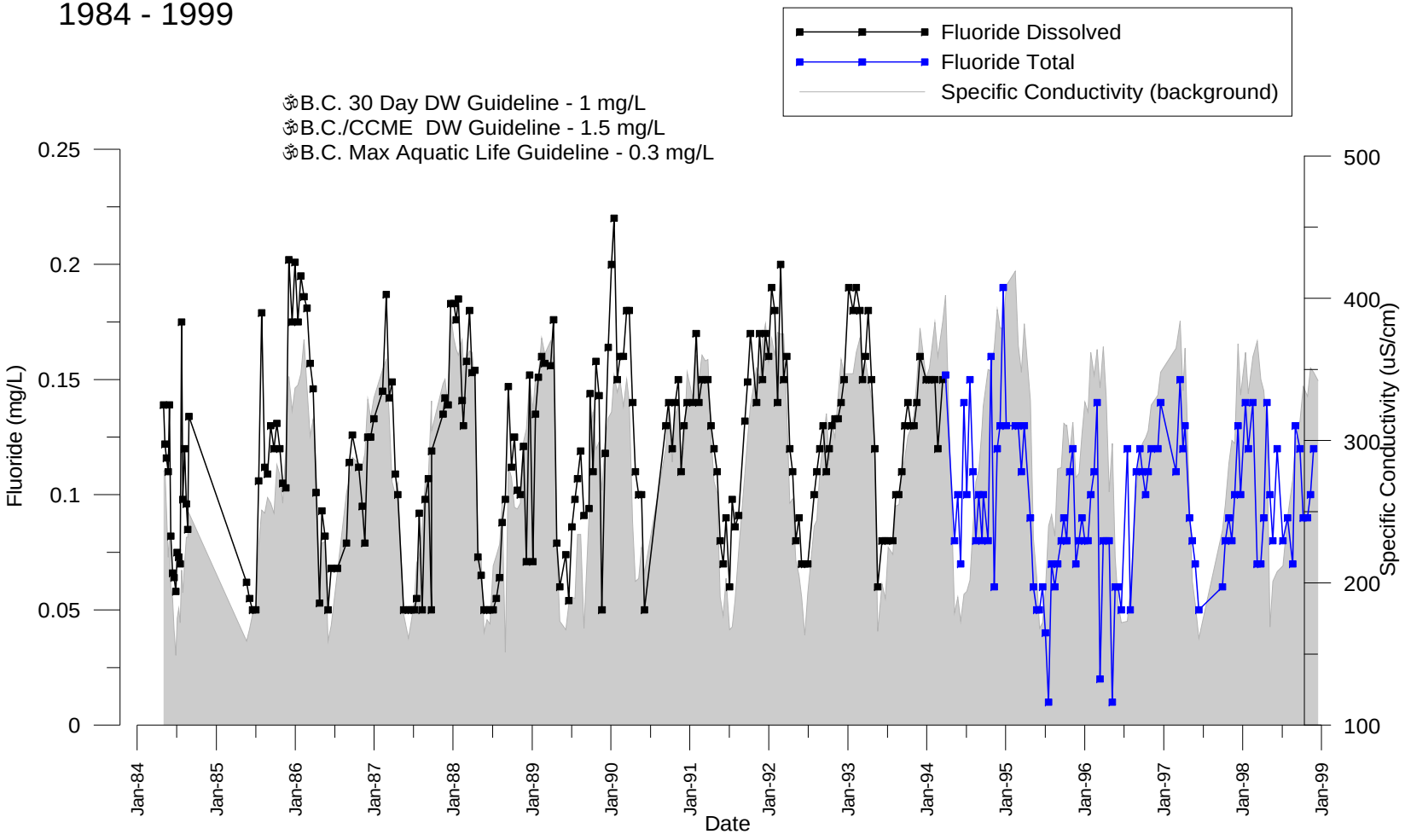

Figure 38 (a)
Kootenay River near Fenwick Station
Fluoride - Total

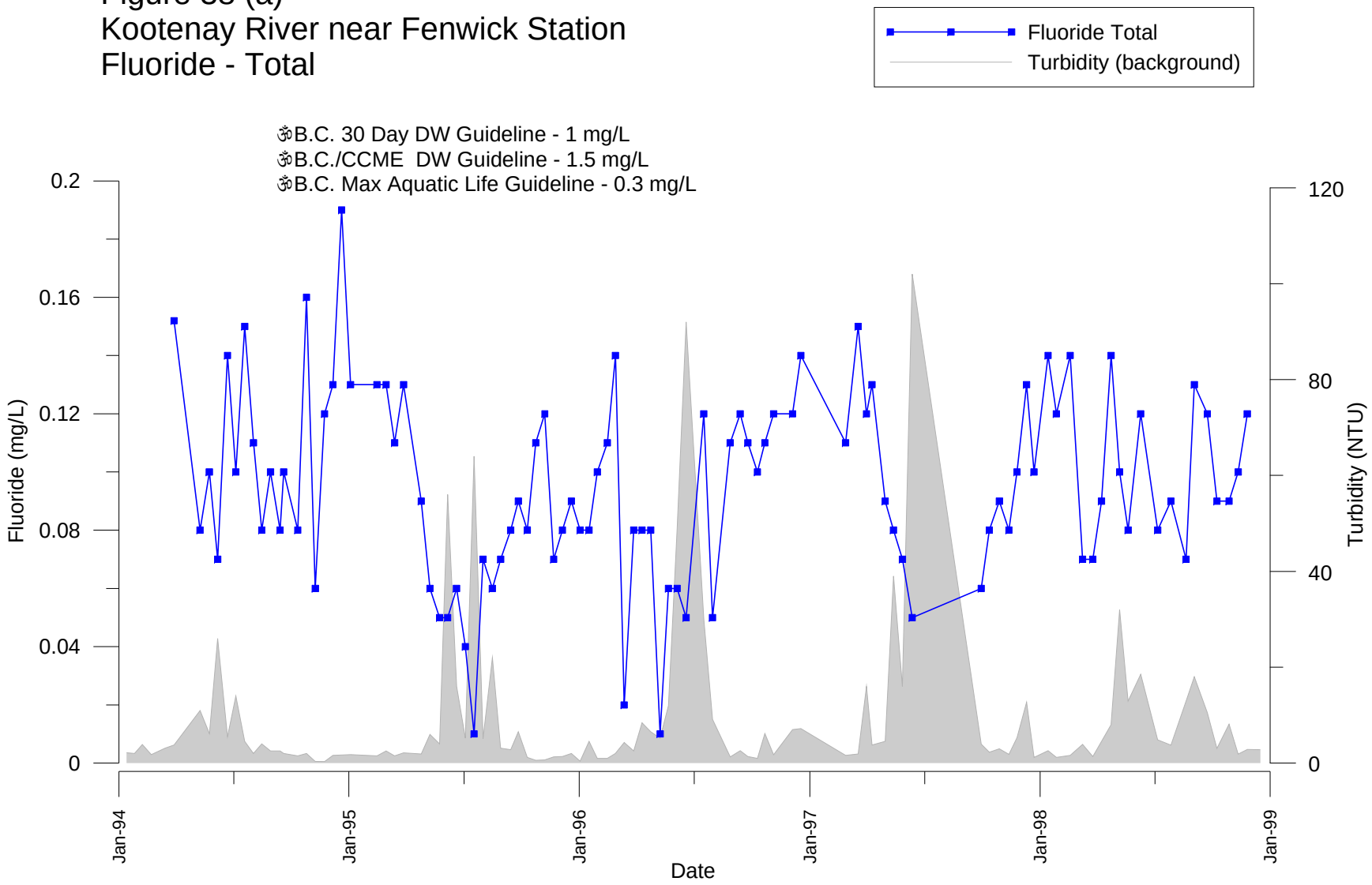

Figure 39
Kootenay River near Fenwick Station
Gallium Total and Extractable
1997 - 2006

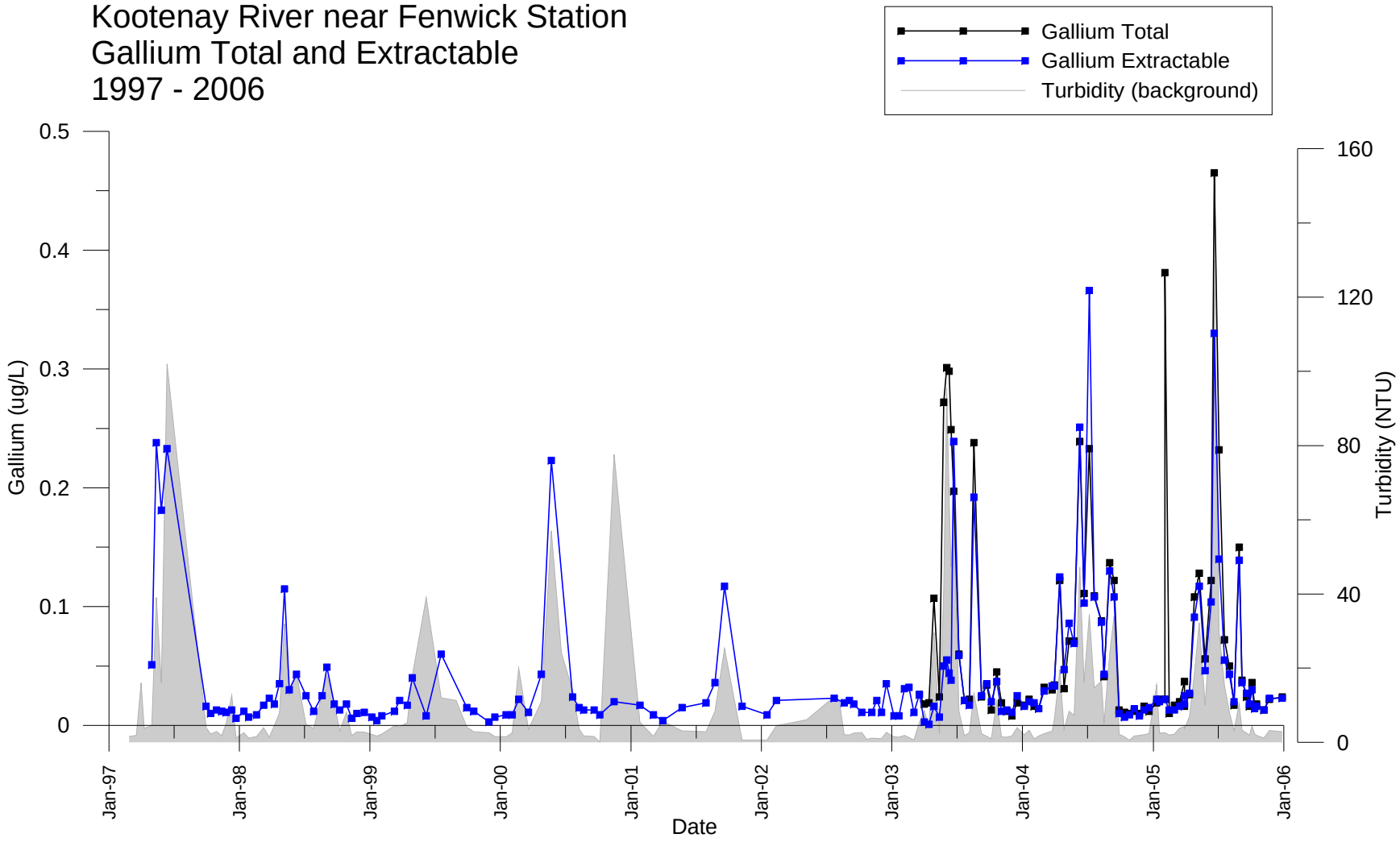

Figure 40
Kootenay River near Fenwick Station
Gallium Total and Extractable

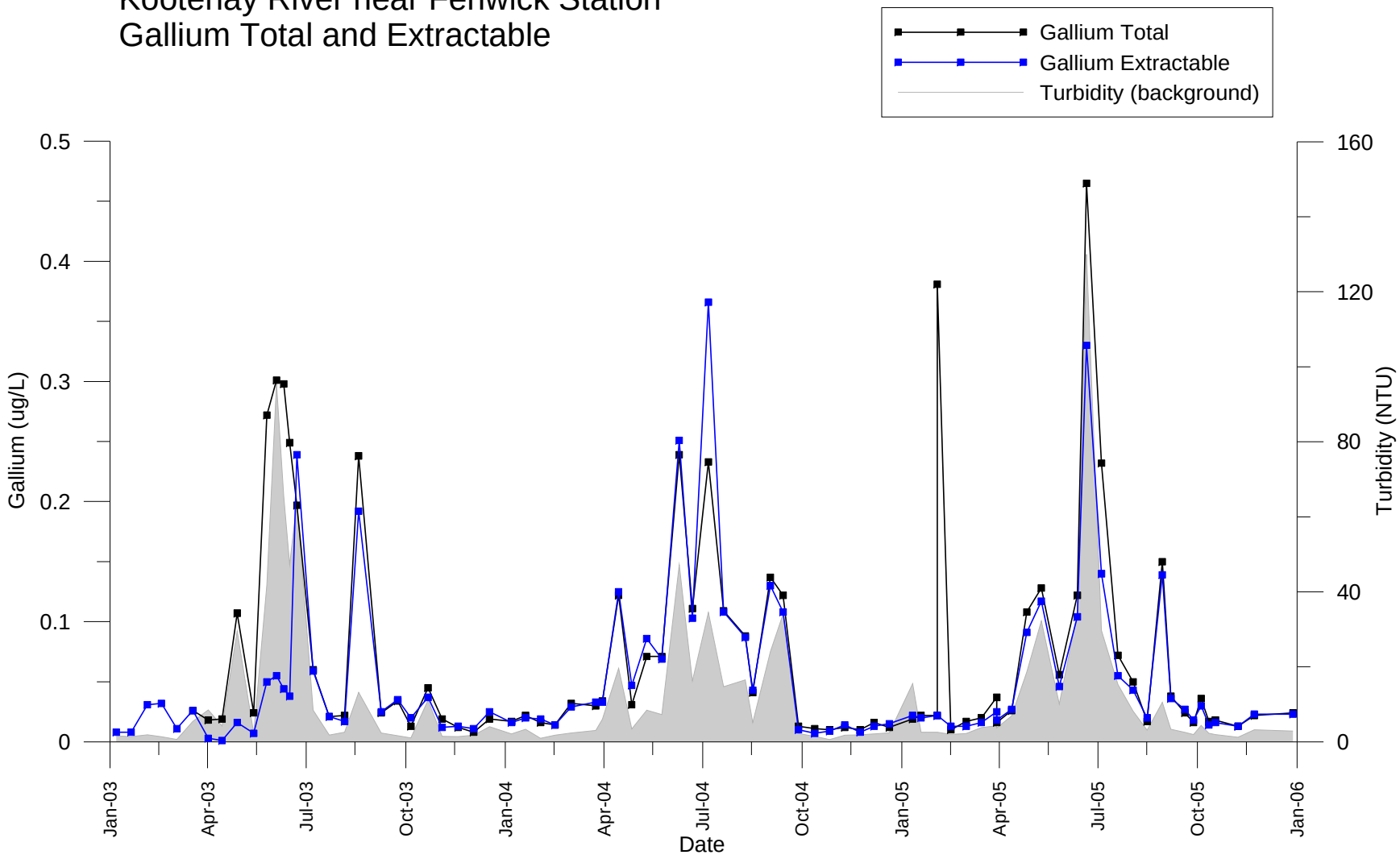

Figure 41
Kootenay River near Fenwick Station
Hardness Total

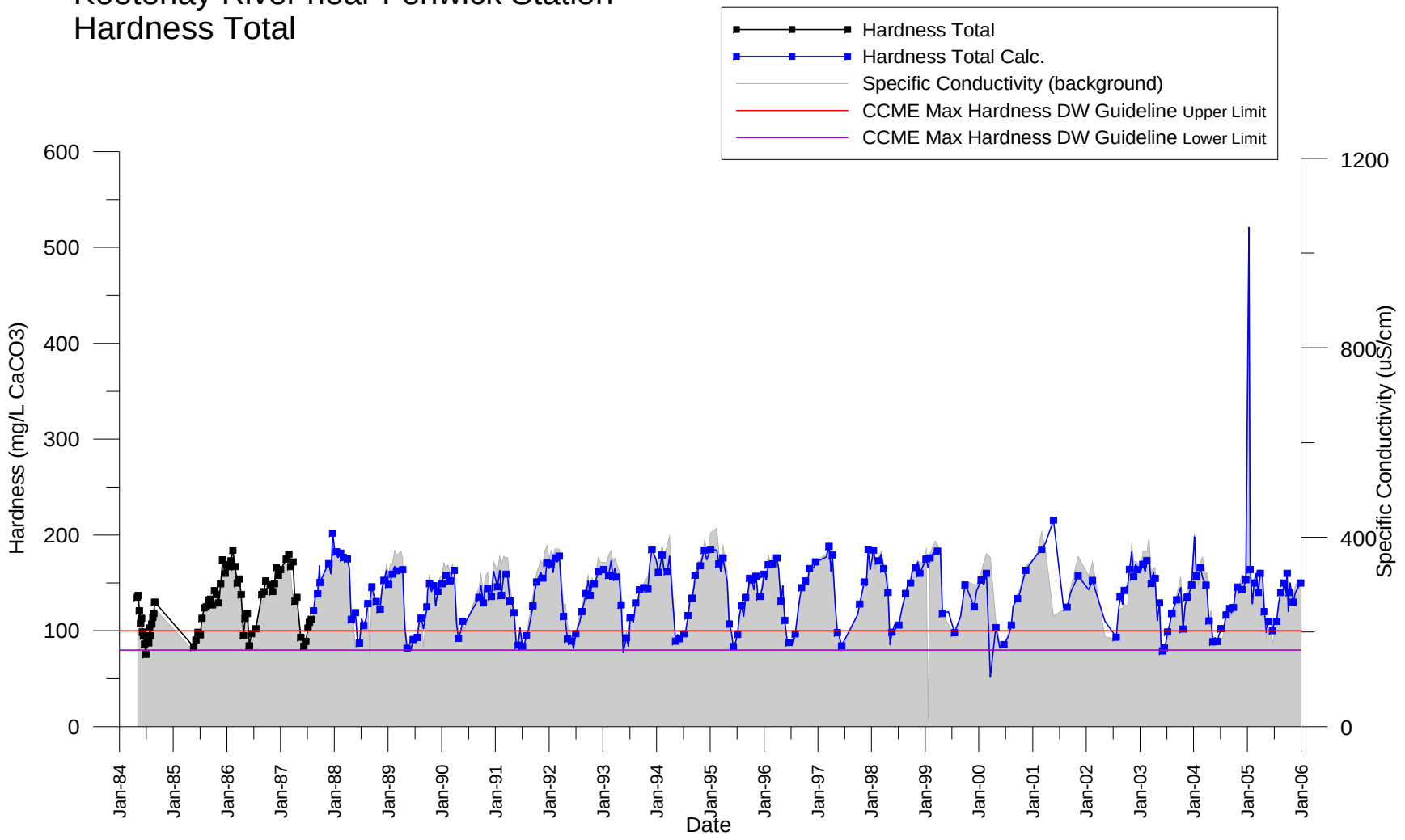

Figure 42
Kootenay River near Fenwick Station
Iron - Total and Extractable
1984 - 2006

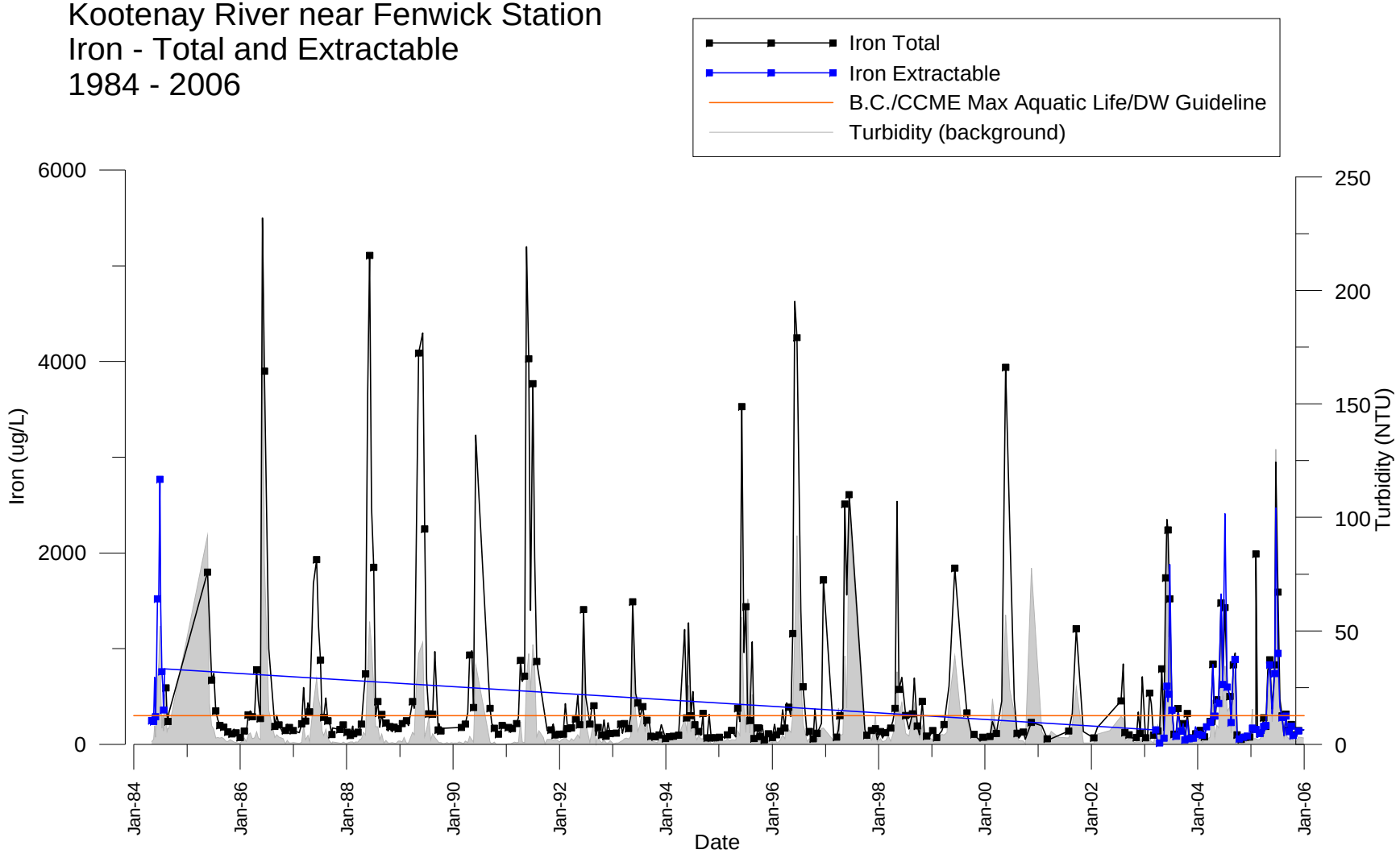

Figure 43
Kootenay River near Fenwick Station
Iron Total and Extractable
2003 - 2006

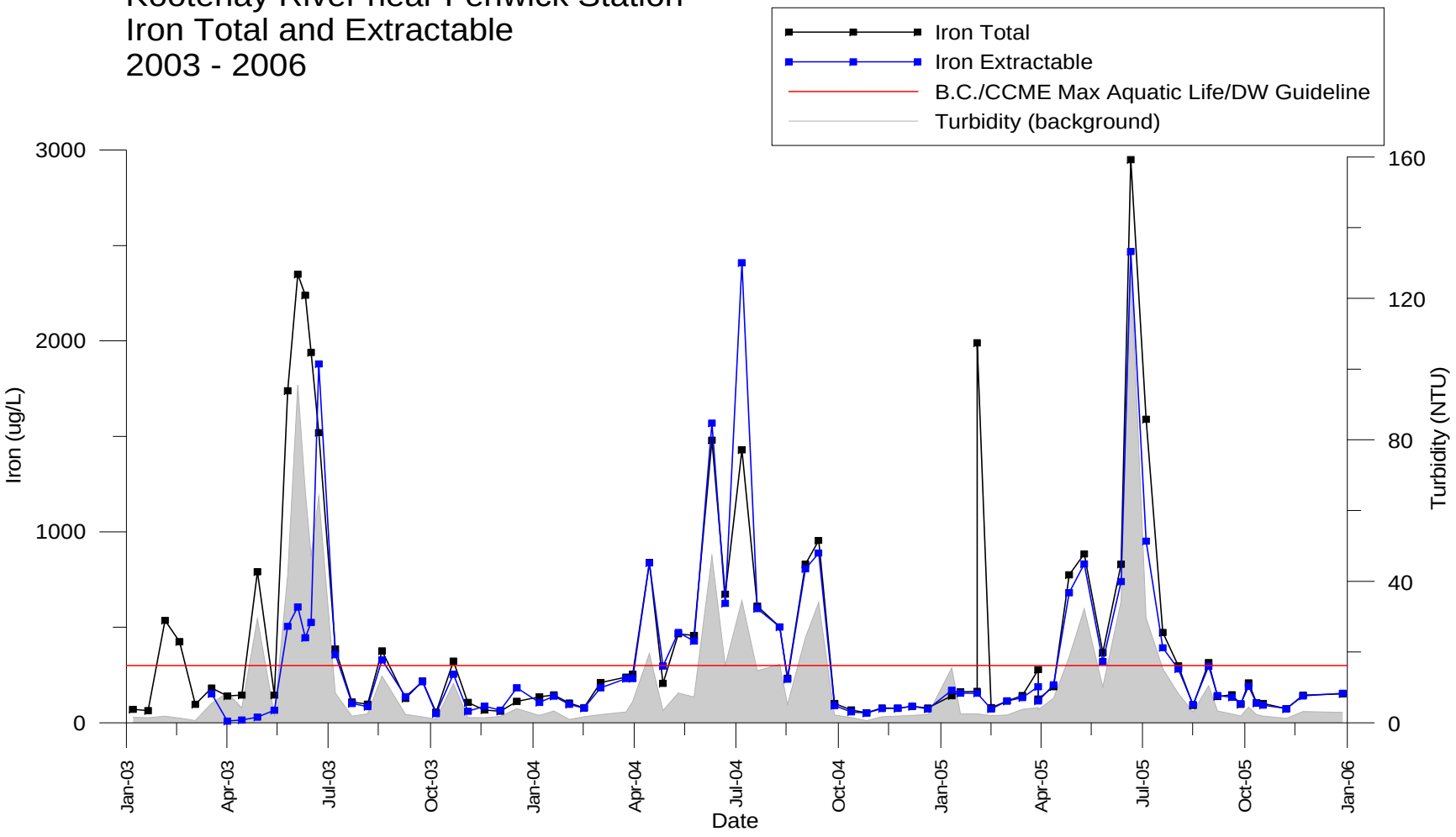

Figure 44
Kootenay River near Fenwick Station
Lanthanum Total and Extractable
1997 - 2006

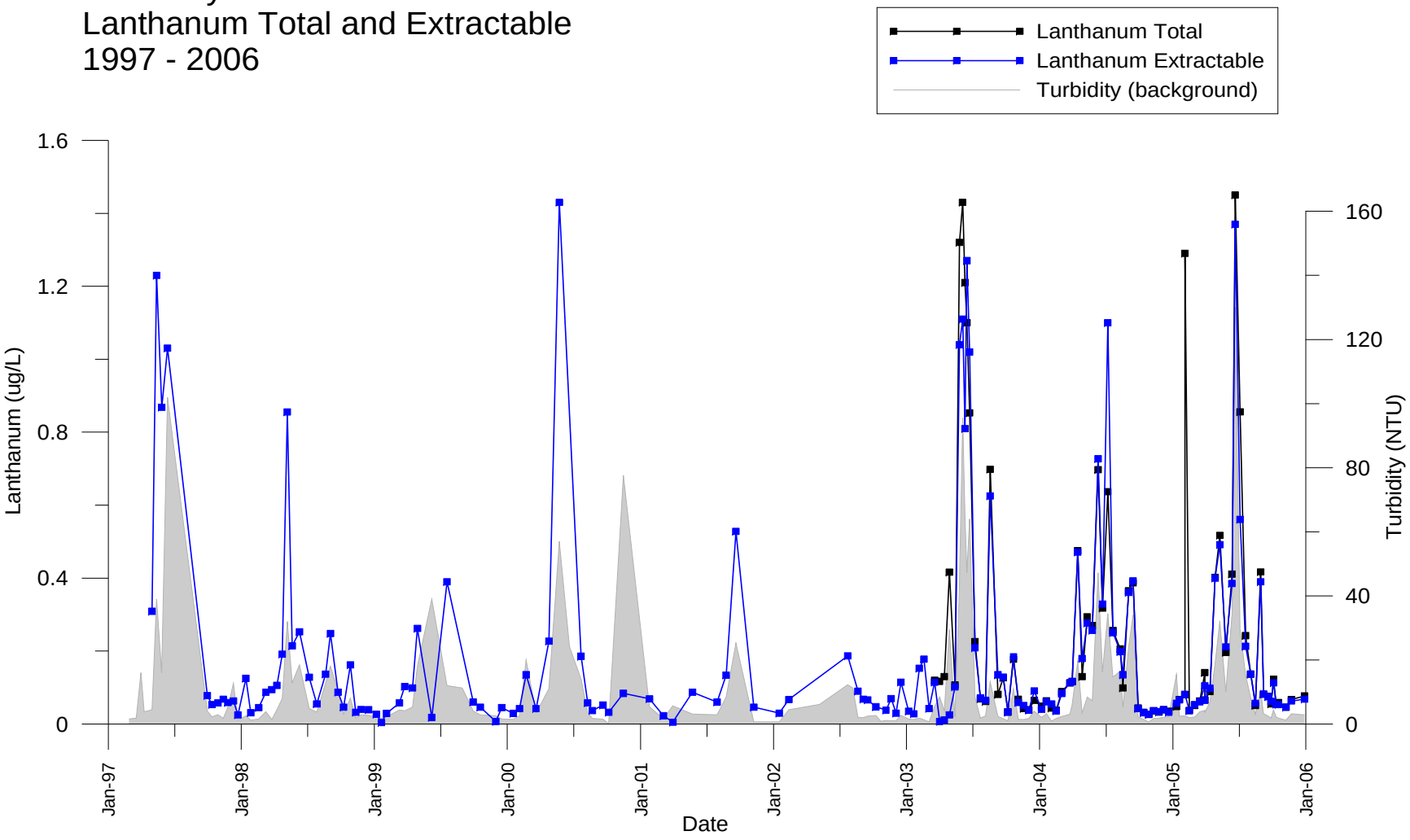

Figure 45
Kootenay River near Fenwick Station
Lanthanum - Total and Extractable

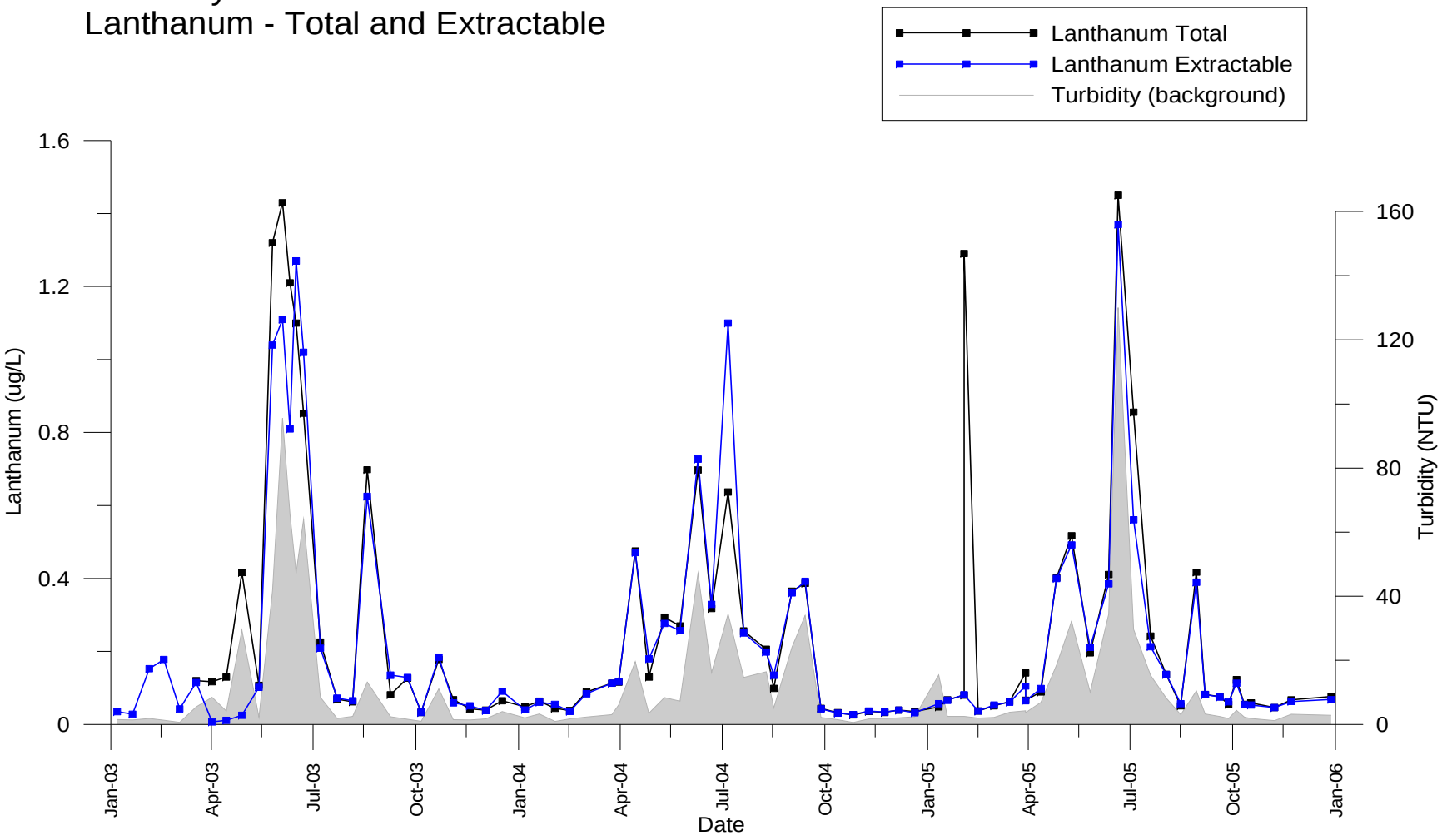

Figure 46
Kootenay River near Fenwick Station
Lead Total and Extractable (ug/L)
1984 - 2005

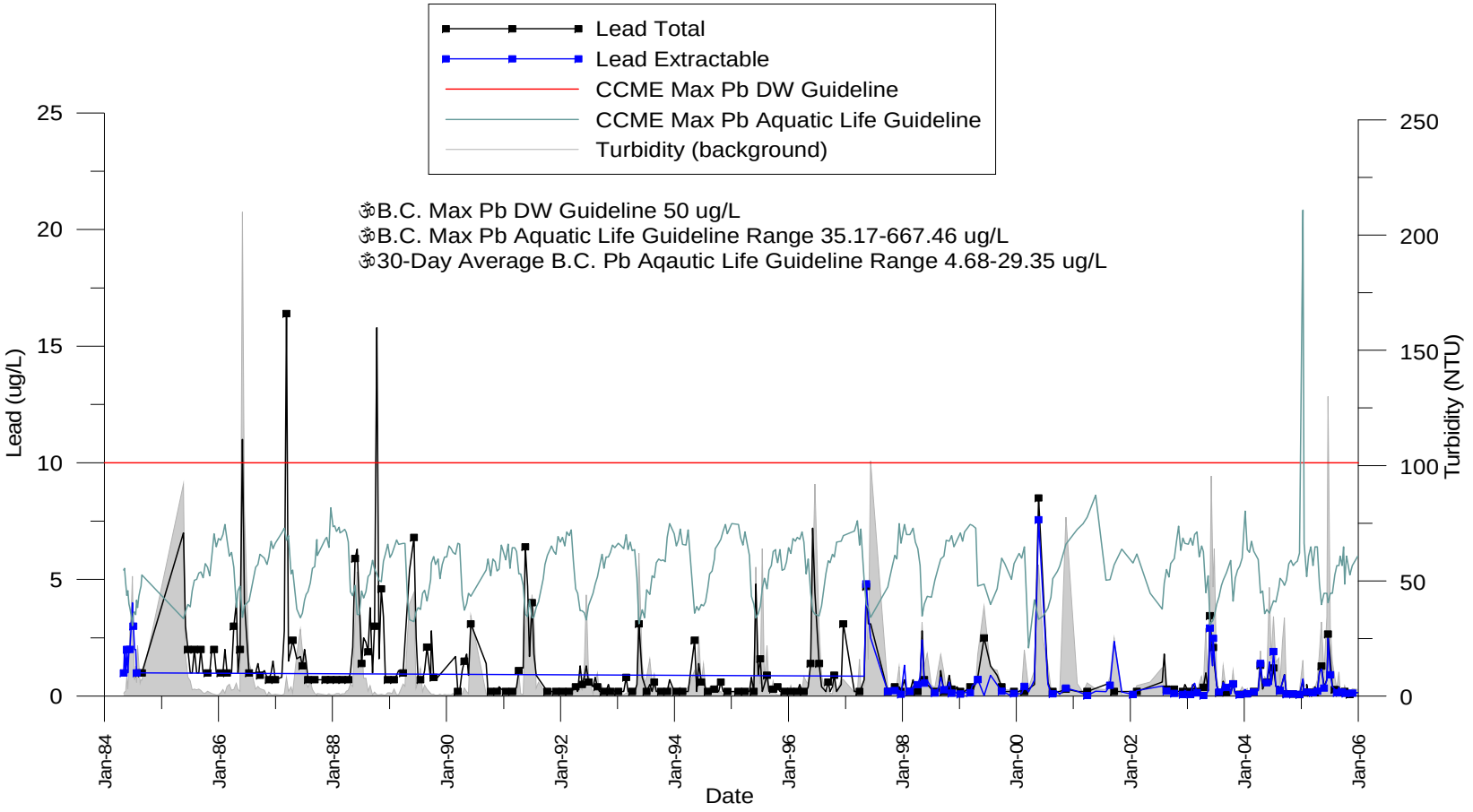

Figure 47
Kootenay River near Fenwick Station
Lead Total and Extractable
1997 - 2005

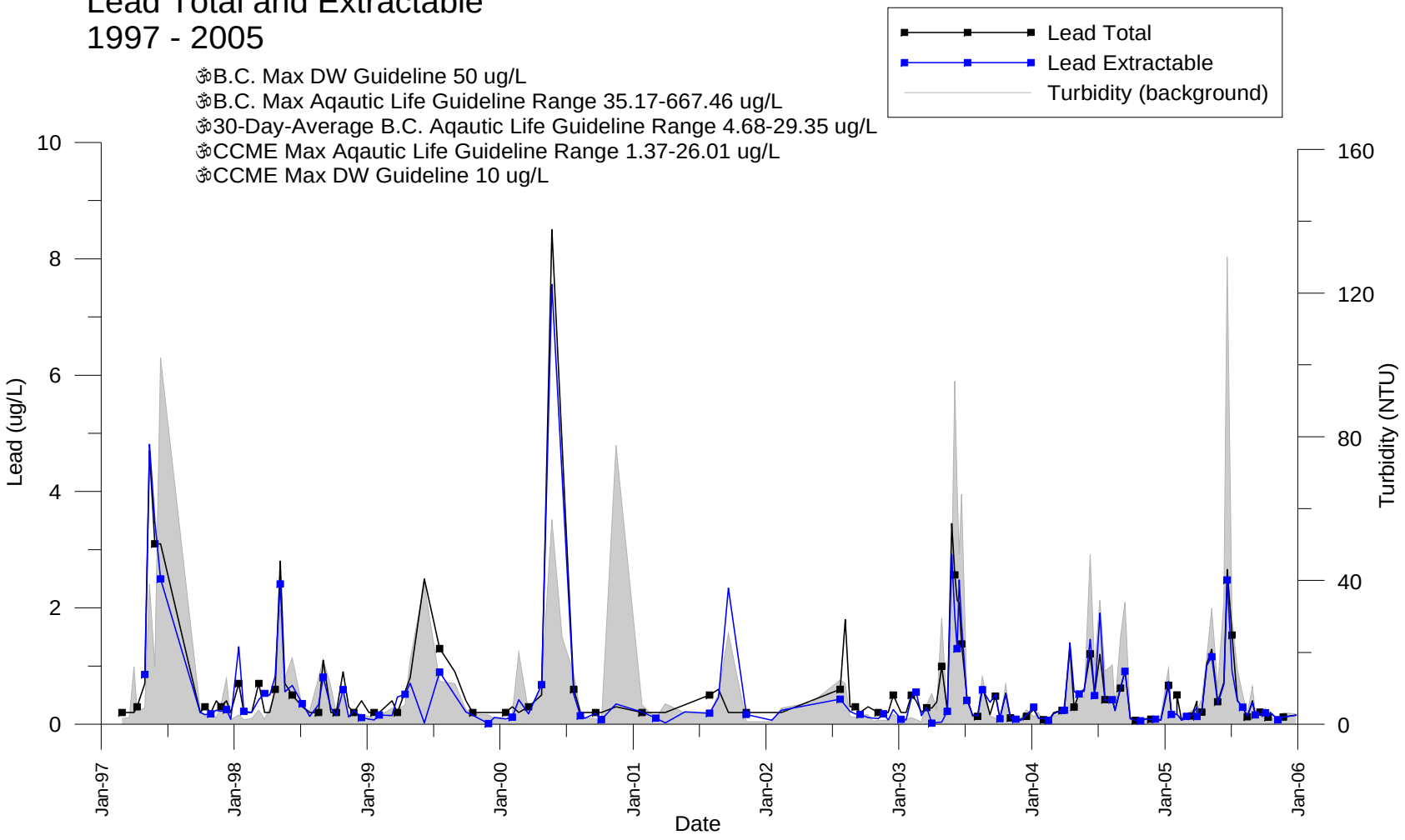

Figure 48
Kootenay River near Fenwick Station
Lithium - Total and Extractable

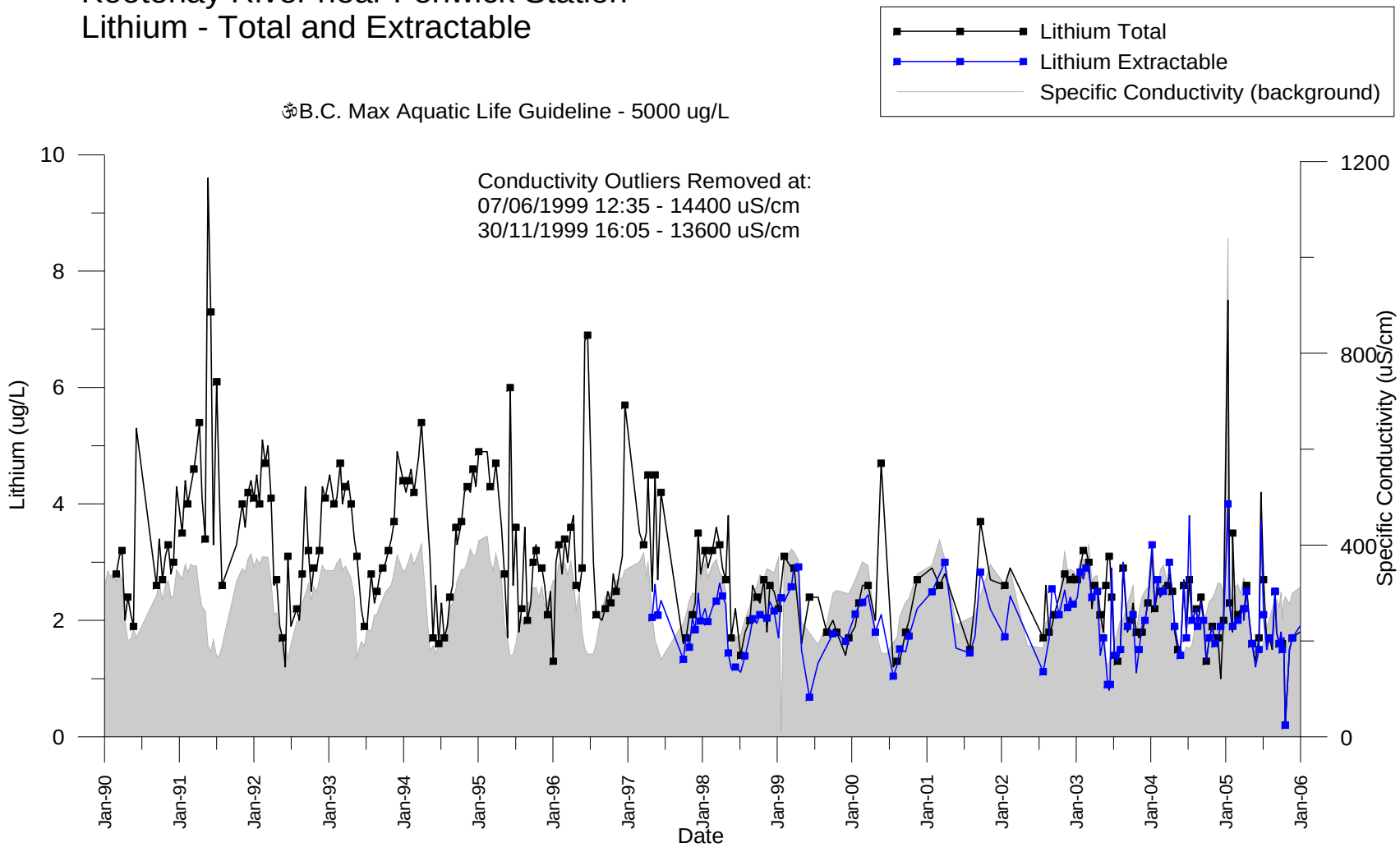

Figure 49
Kootenay River near Fenwick Station
Lithium Total and Extractable
1997 - 2006

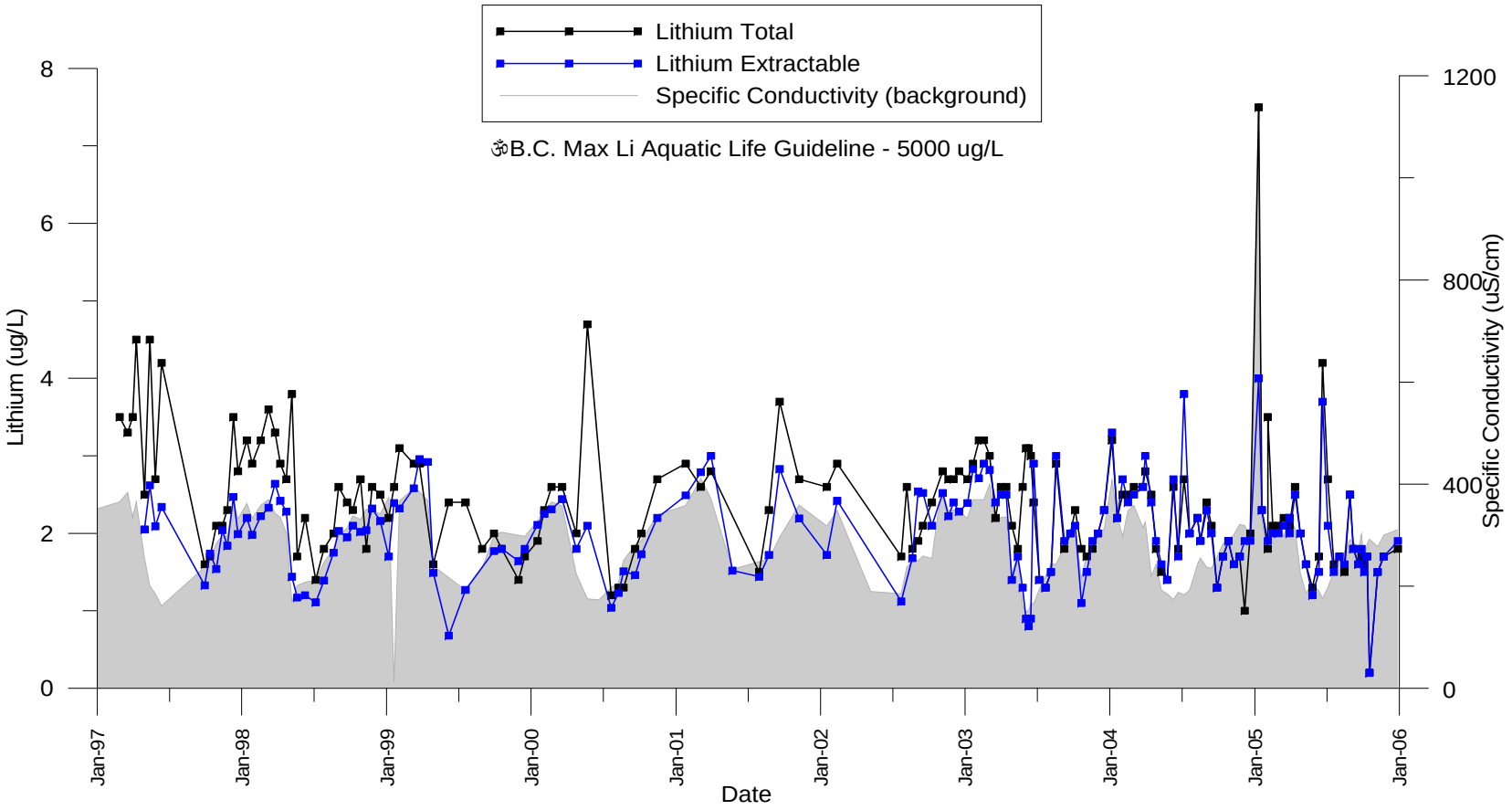

Figure 50
Kootenay River near Fenwick Station
Magnesium - Dissolved and Extractable

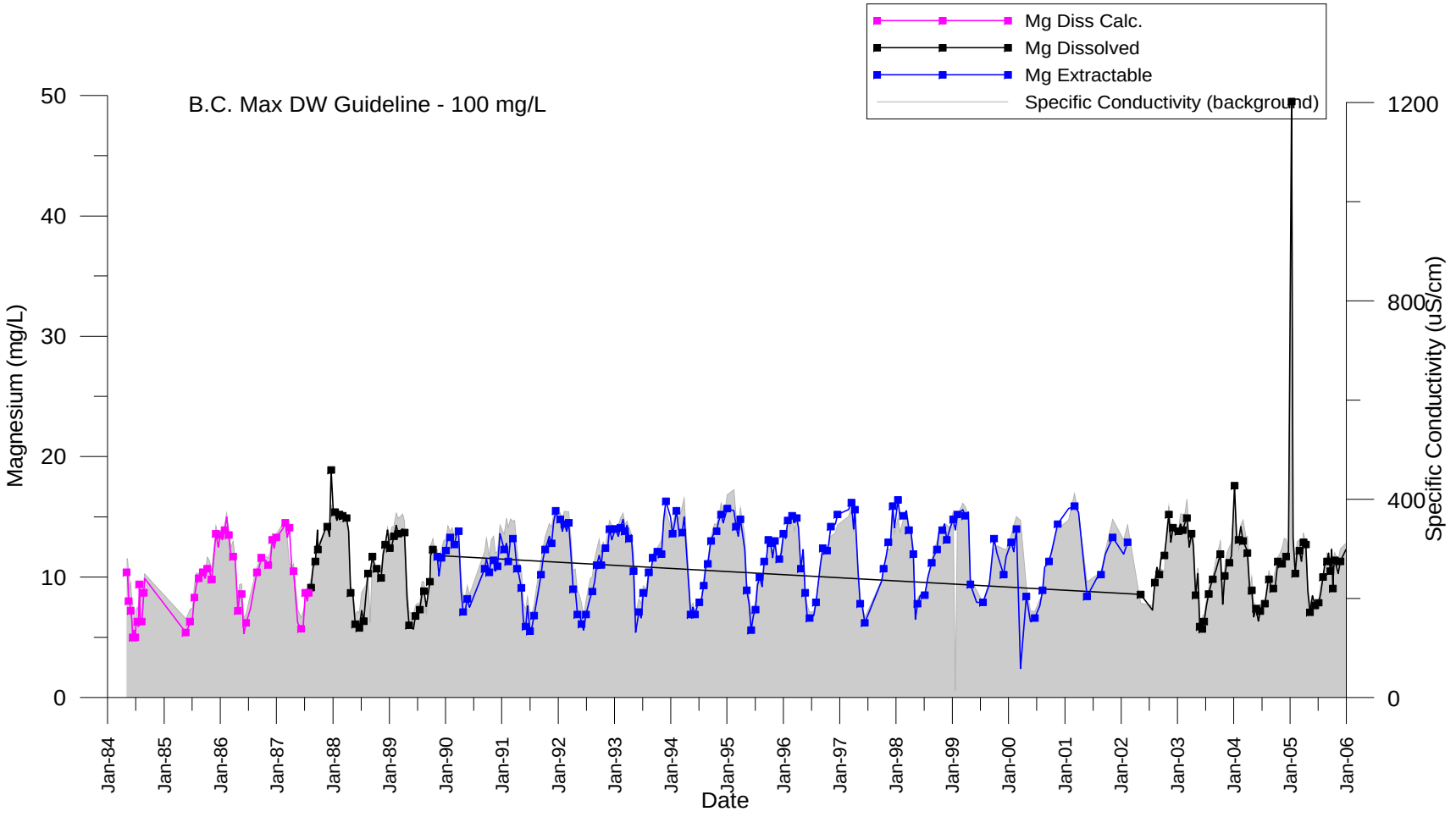

Figure 51
Kootenay River near Fenwick Station
Manganese - Total and Extractable
1984 - 2005

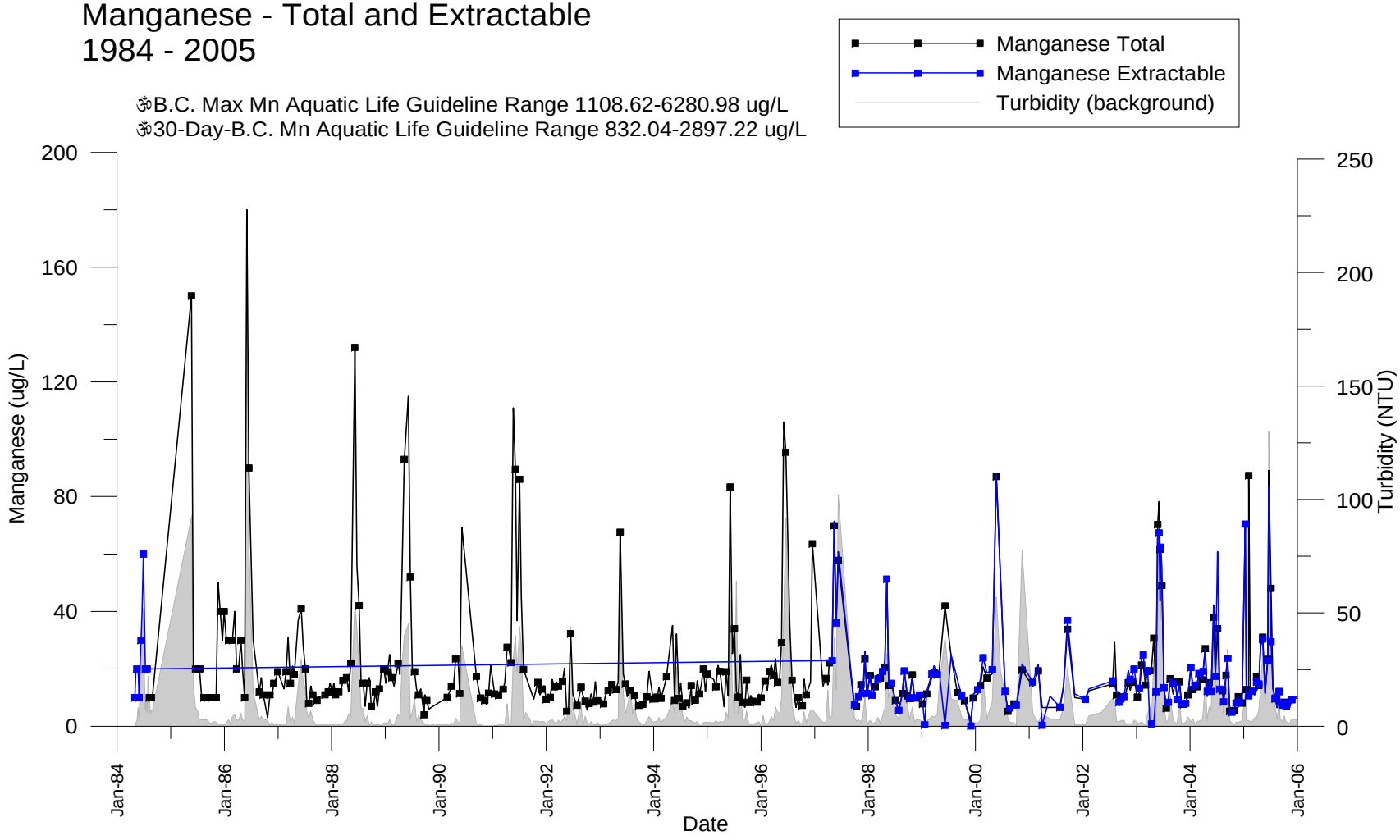

Figure 52
Kootenay River near Fenwick Station
Manganese - Total and Extractable

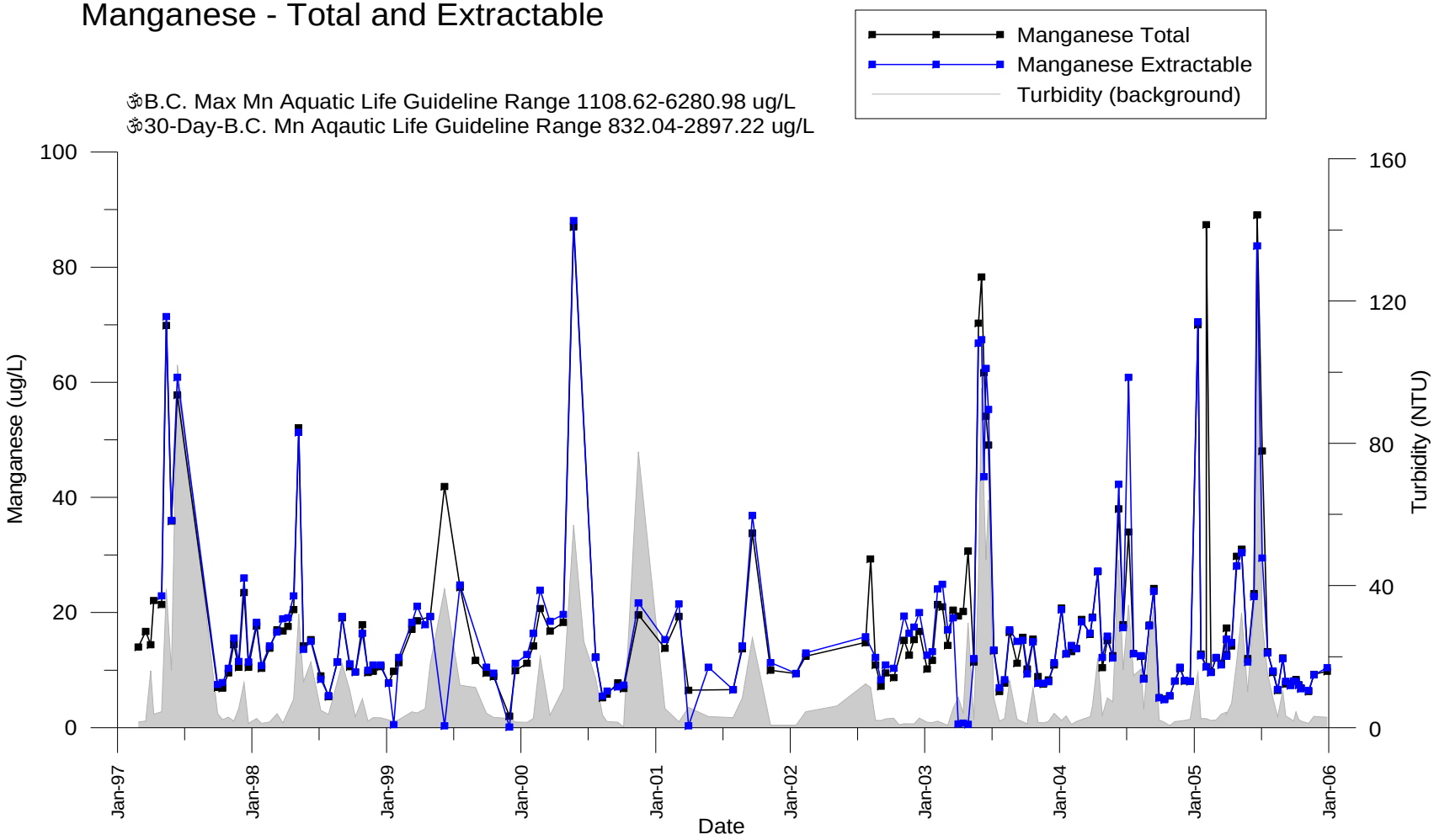

Figure 53
Kootenay River near Fenwick Station
Mercury Total and Extractable
1984 - 1995

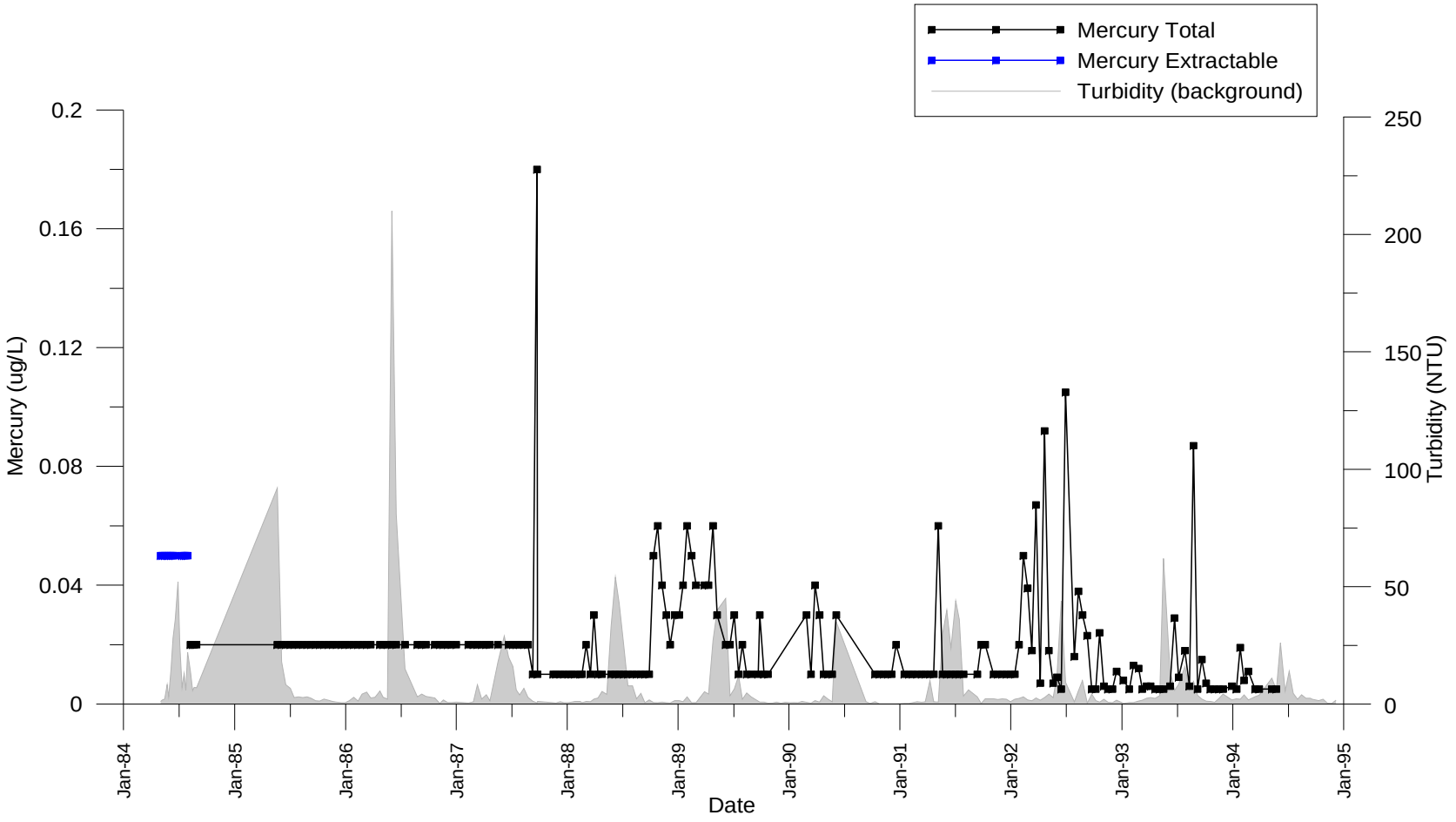

Figure 54
Kootenay River near Fenwick Station
Molybdenum - Total and Extractable

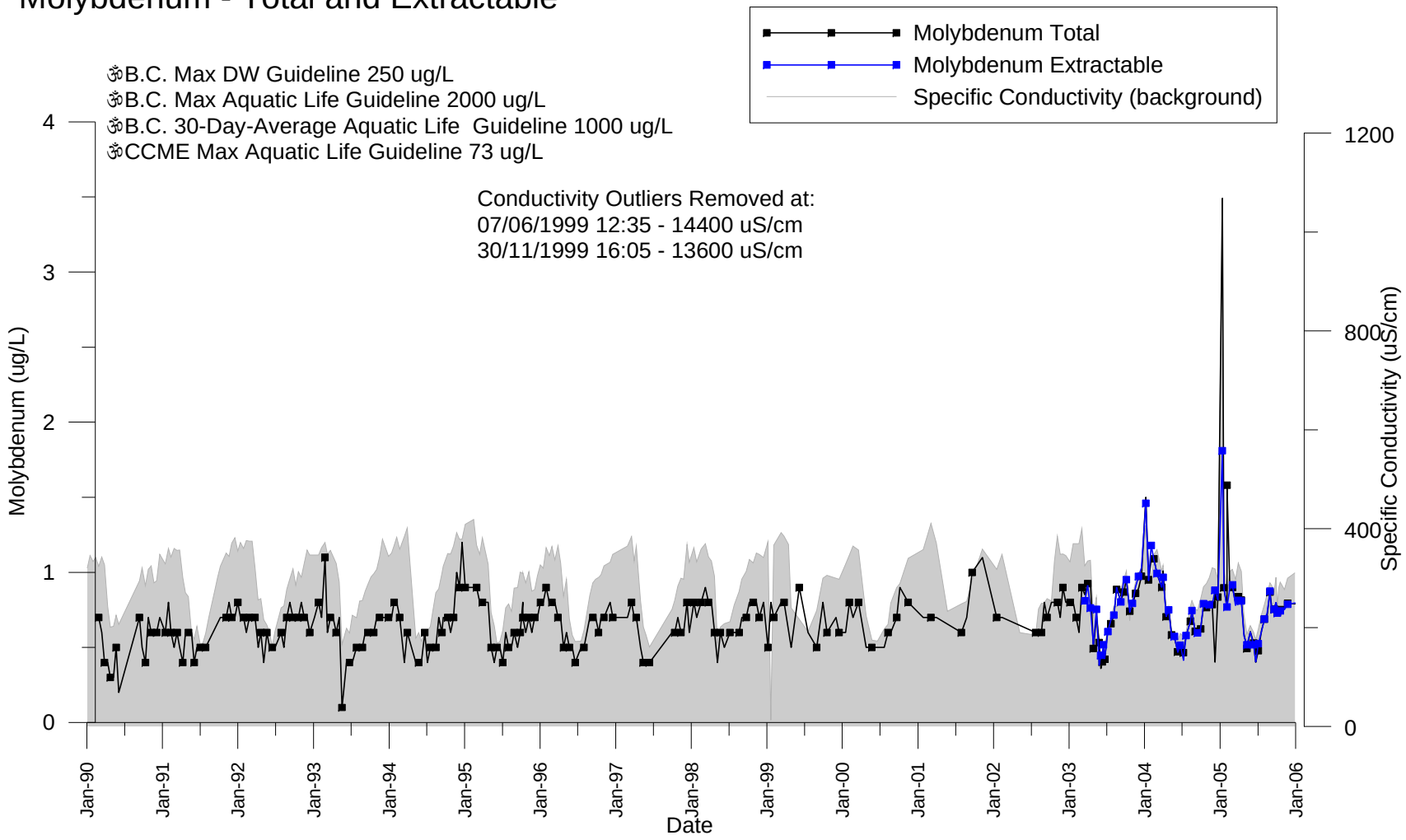

Figure 55
Kootenay River near Fenwick Station
Nickel Total and Extractable

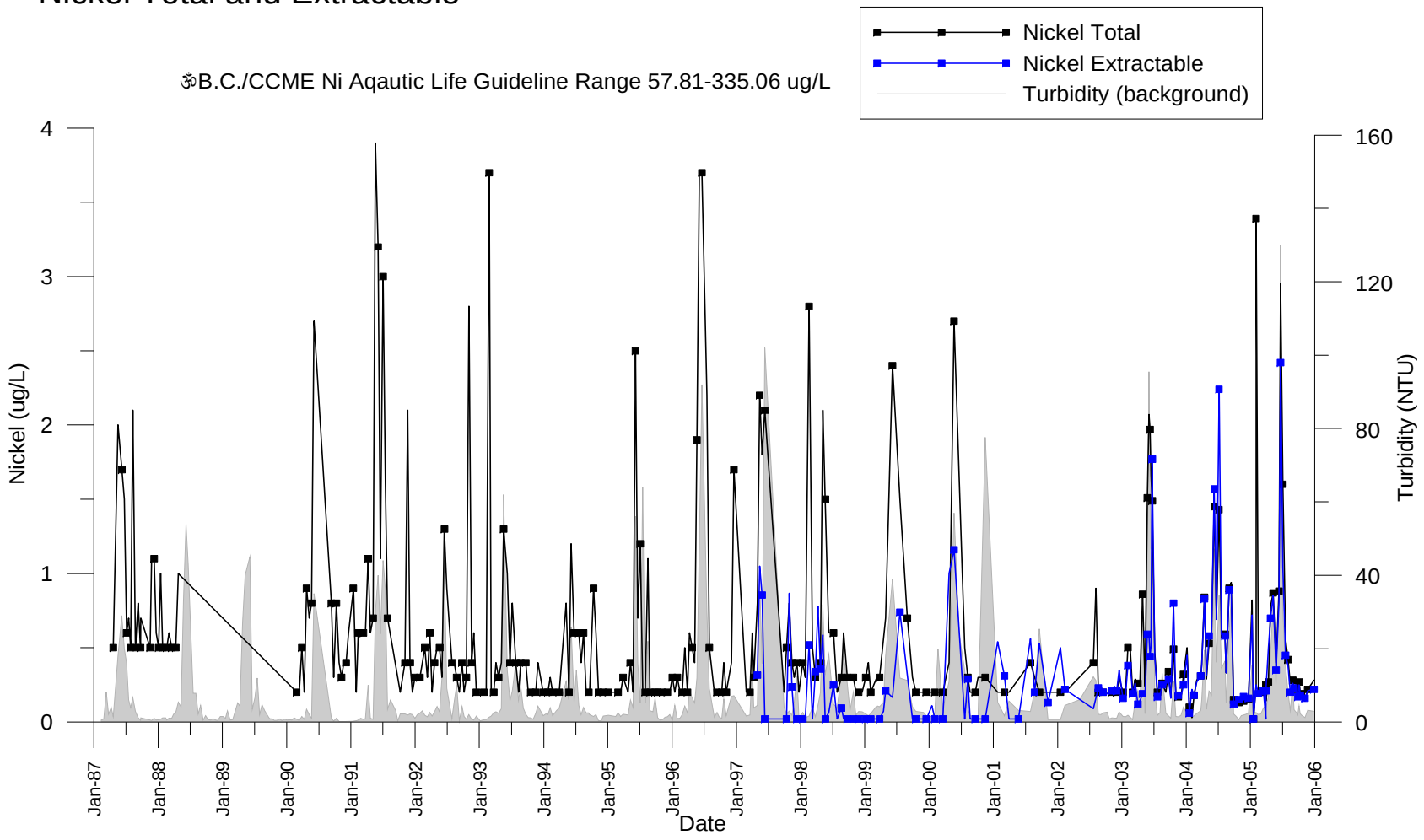

Figure 56
Kootenay River near Fenwick Station
Niobium Extractable

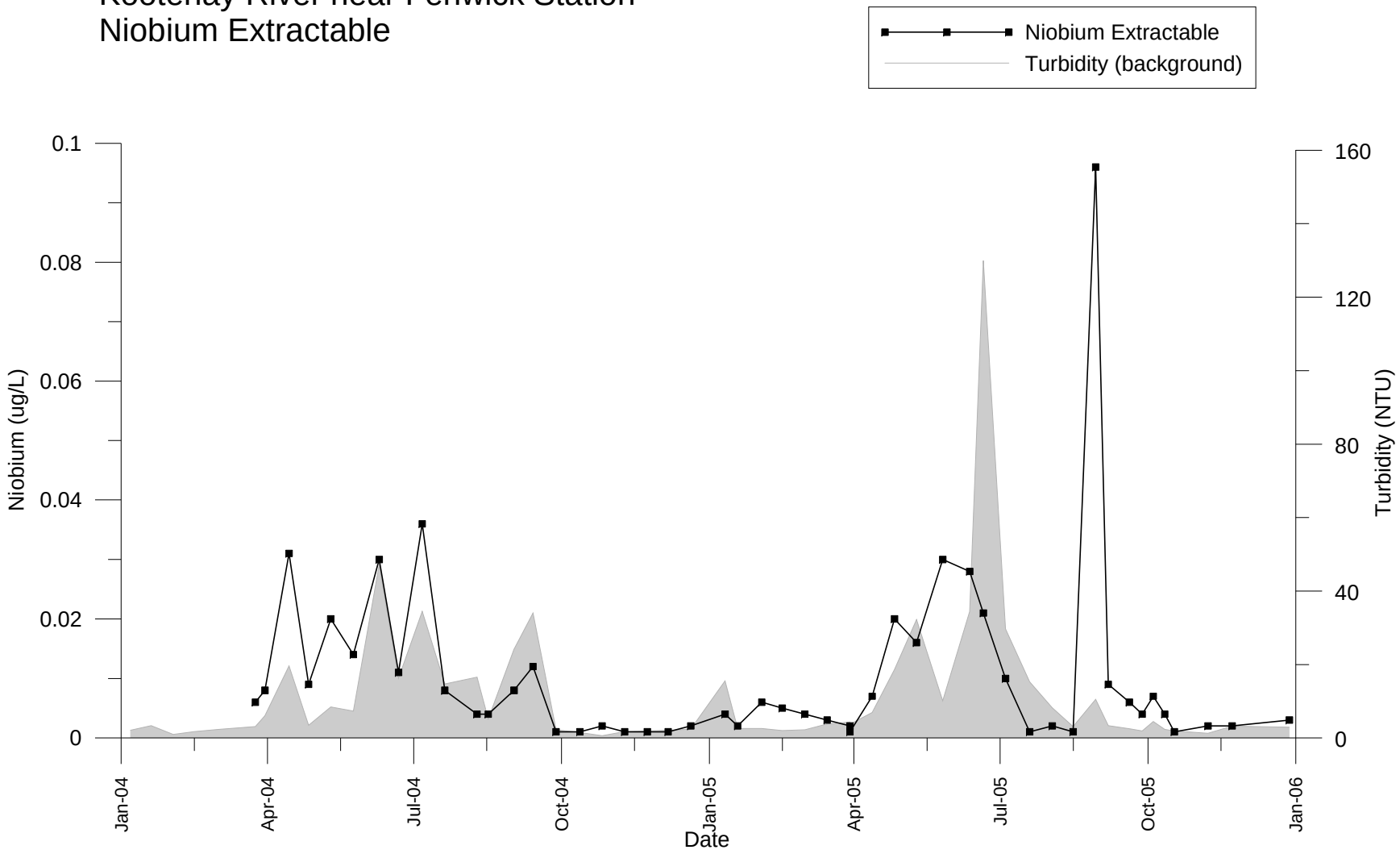

Figure 57
Kootenay River near Fenwick Station
Nitrogen Dissolved Nitrate
1994 - 1999

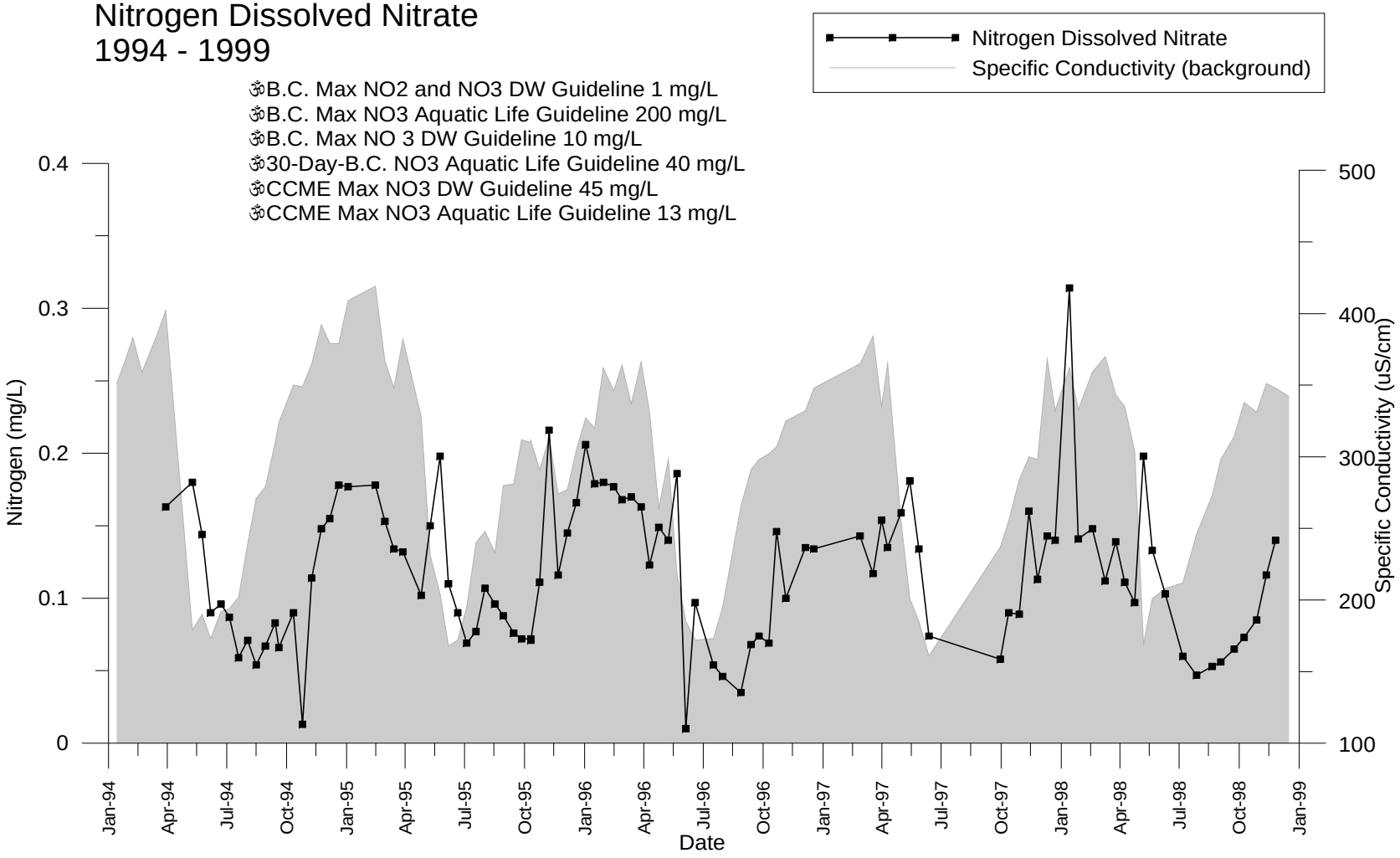

Figure 58
Kootenay River near Fenwick Station
Nitrogen Dissolved NO3 and NO2

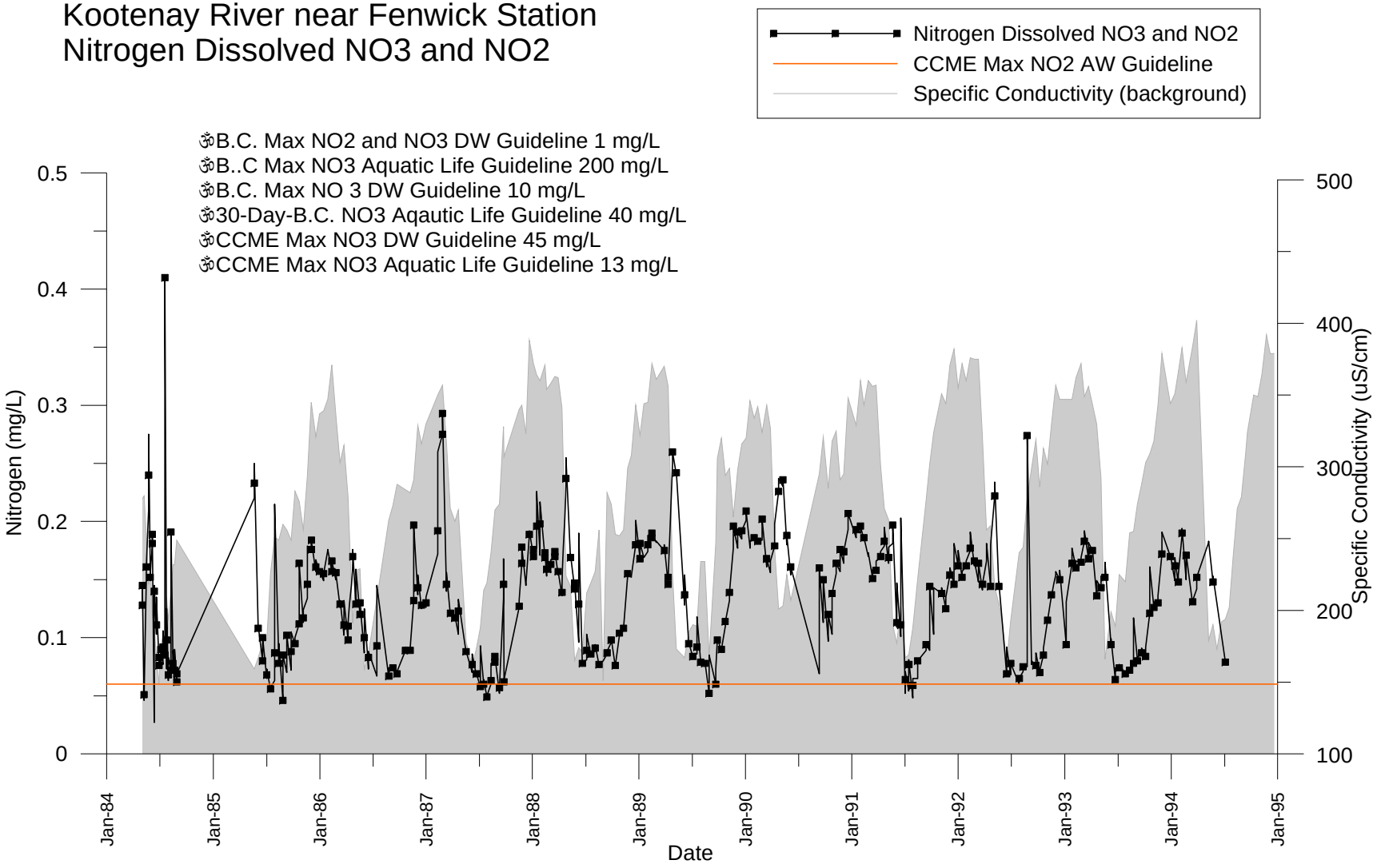

Figure 59
Kootenay River near Fenwick Station
Nitrogen - Nitrite

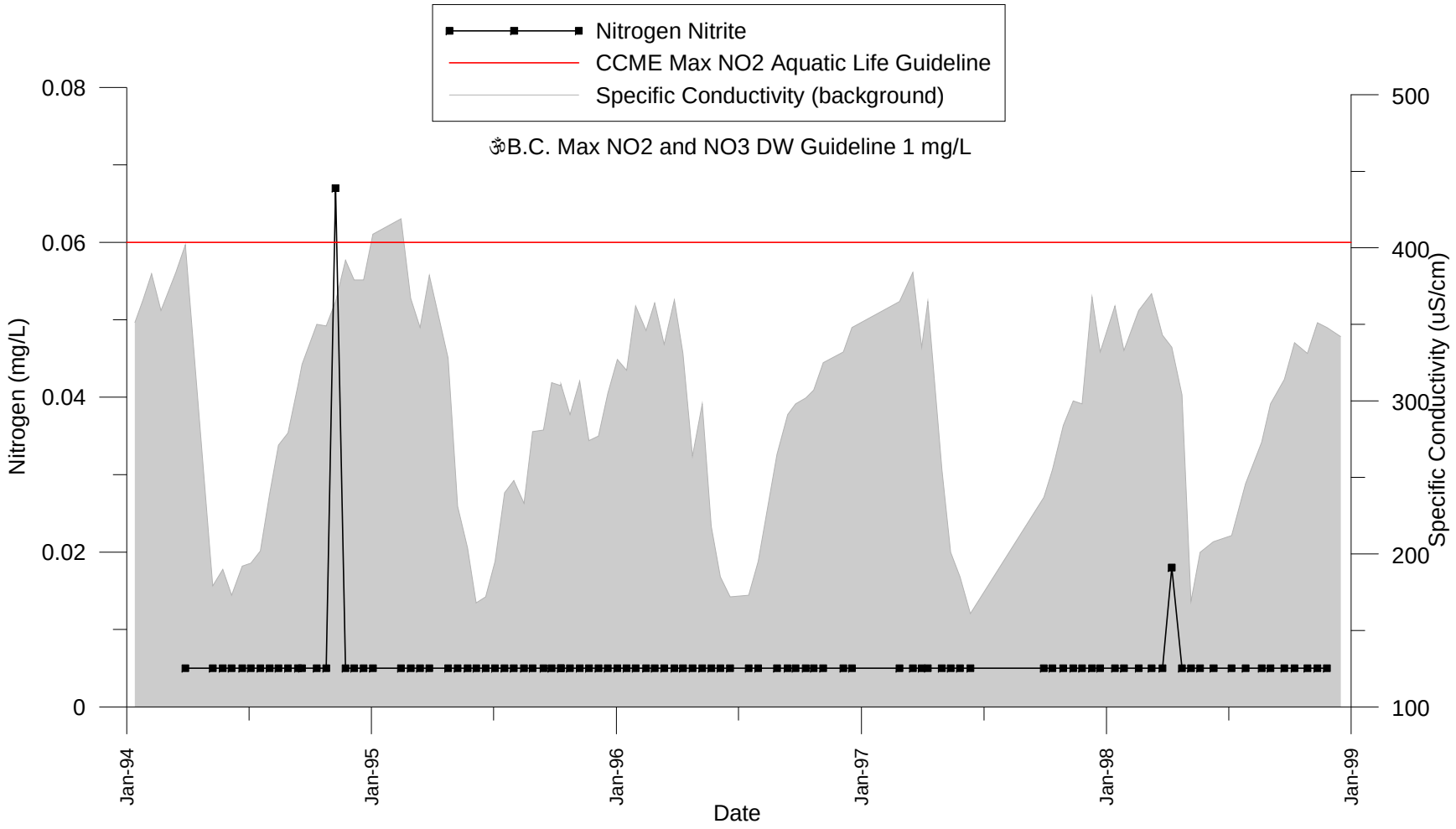

Figure 60
Kootenay River near Fenwick Station
Nitrogen - Total

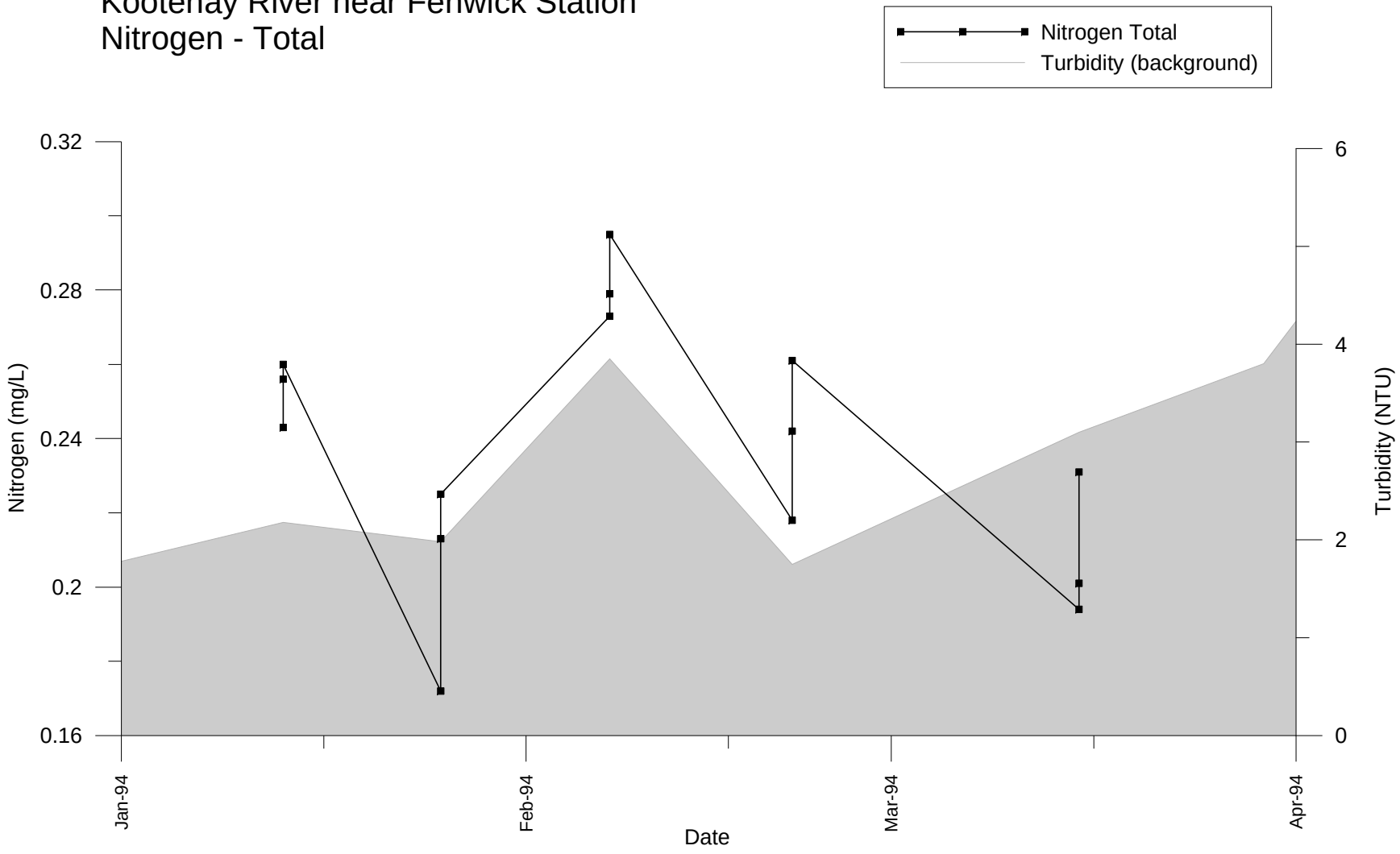

Figure 61
Kootenay River near Fenwick Station
Nitrogen - Total Dissolved

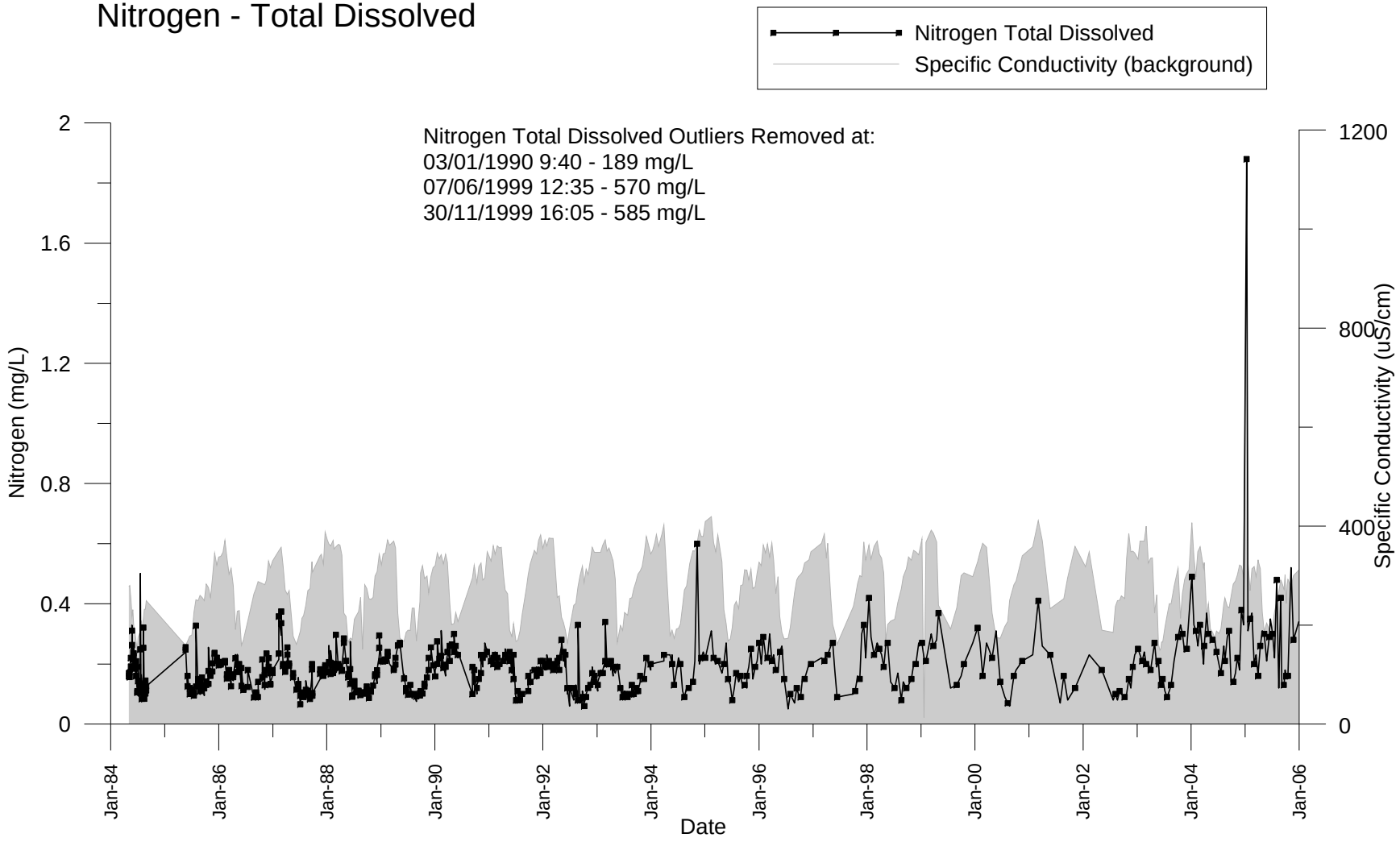

Figure 62
Kootenay River near Fenwick Station
pH

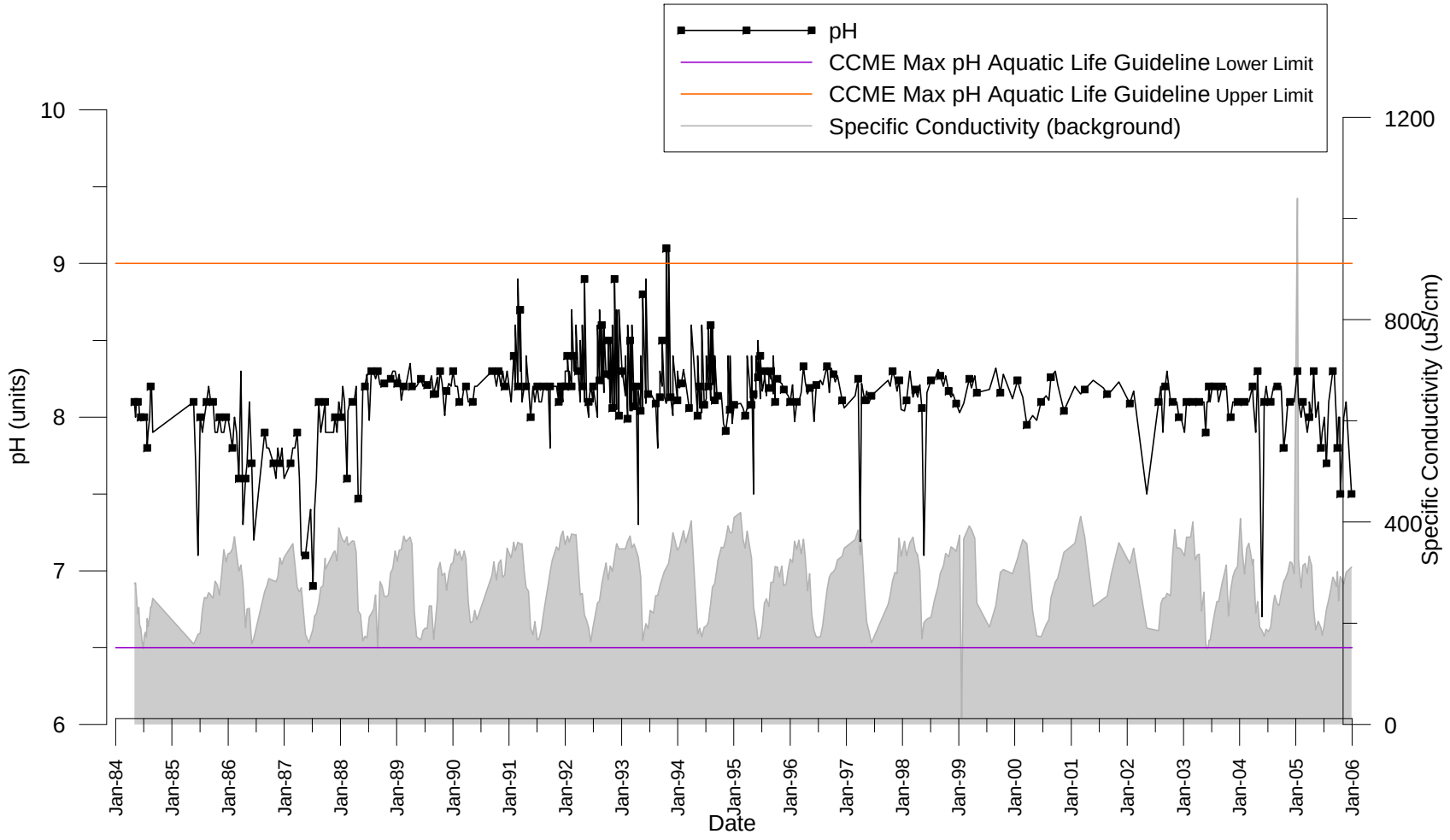

Figure 63
Kootenay River near Fenwick Station
Phosphate - Dissolved Ortho

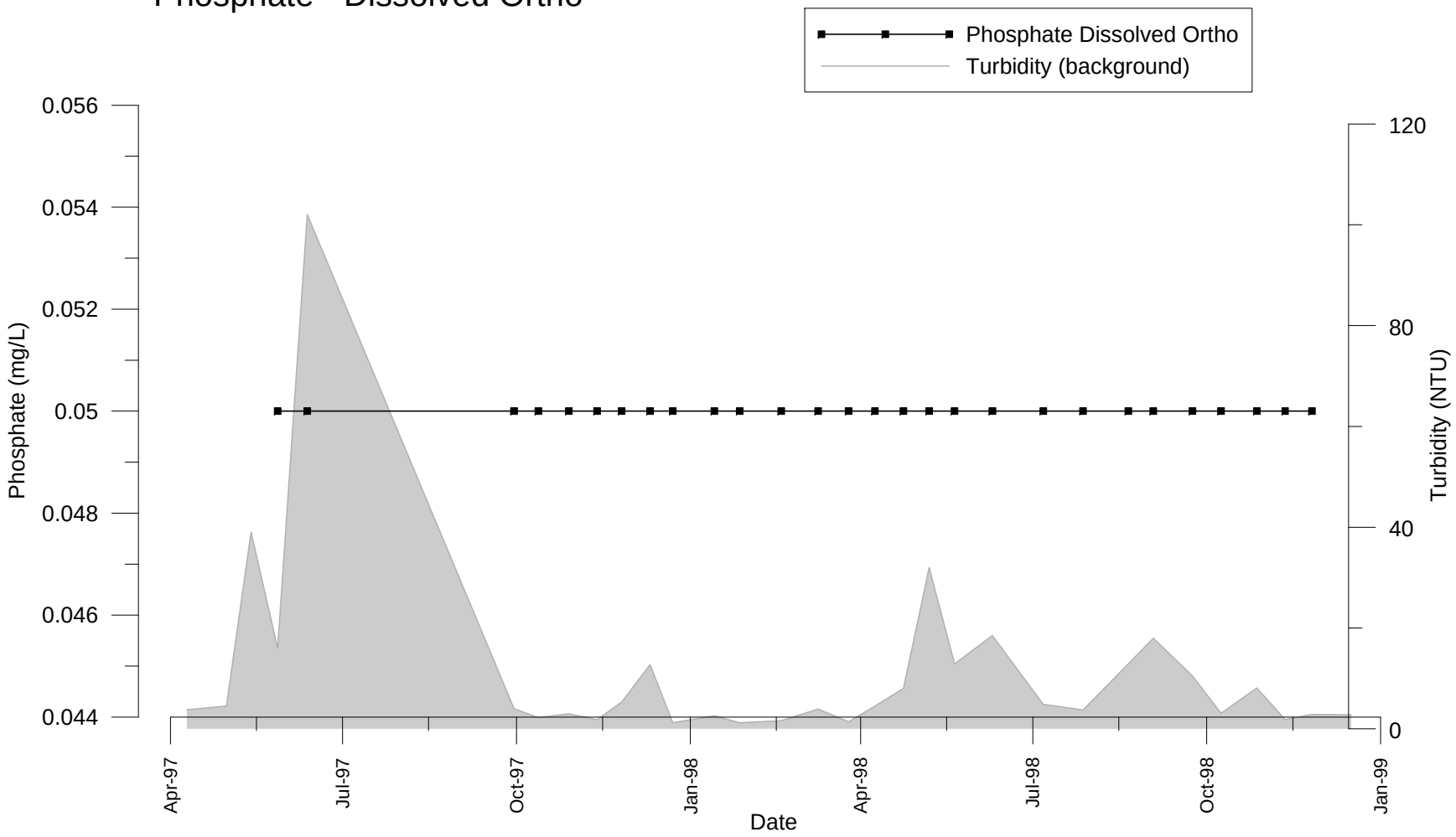

Figure 64
Kootenay River near Fenwick Station
Phosphorus - Dissolved Ortho

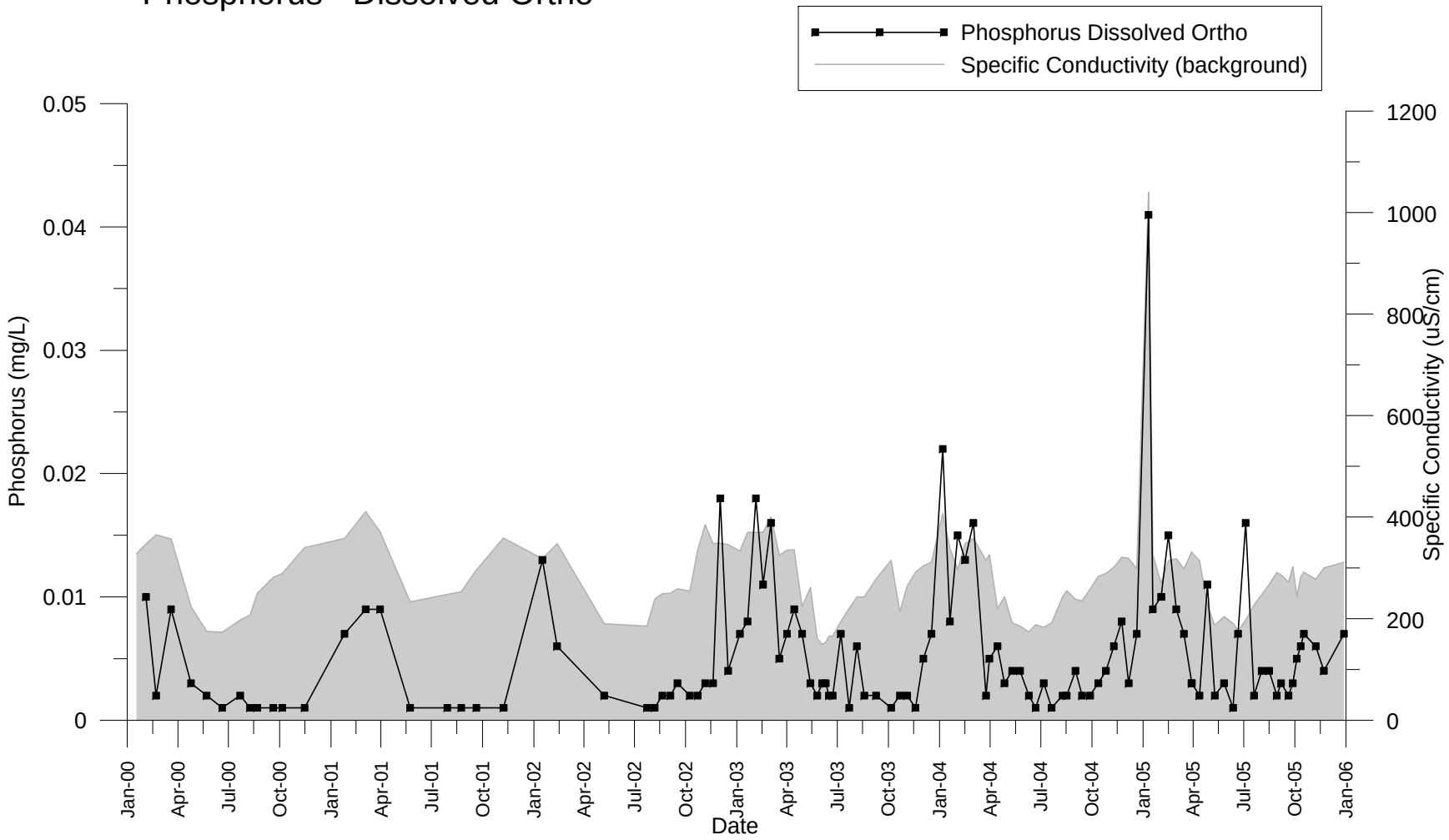

Figure 65
Kootenay River near Fenwick Station
Phosphorus - Total

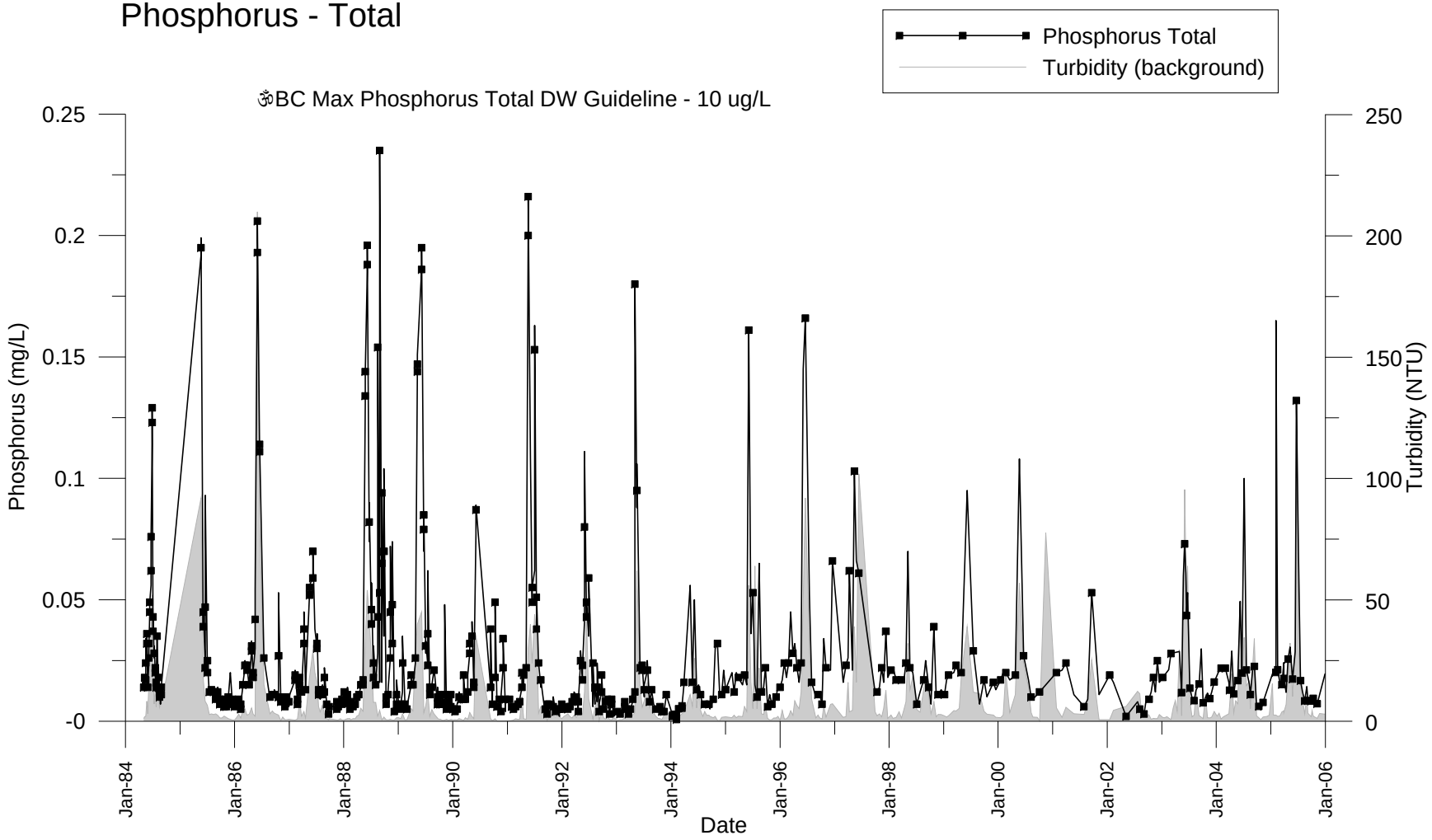

Figure 66
Kootenay River near Fenwick Station
Potassium - Dissolved and Extractable

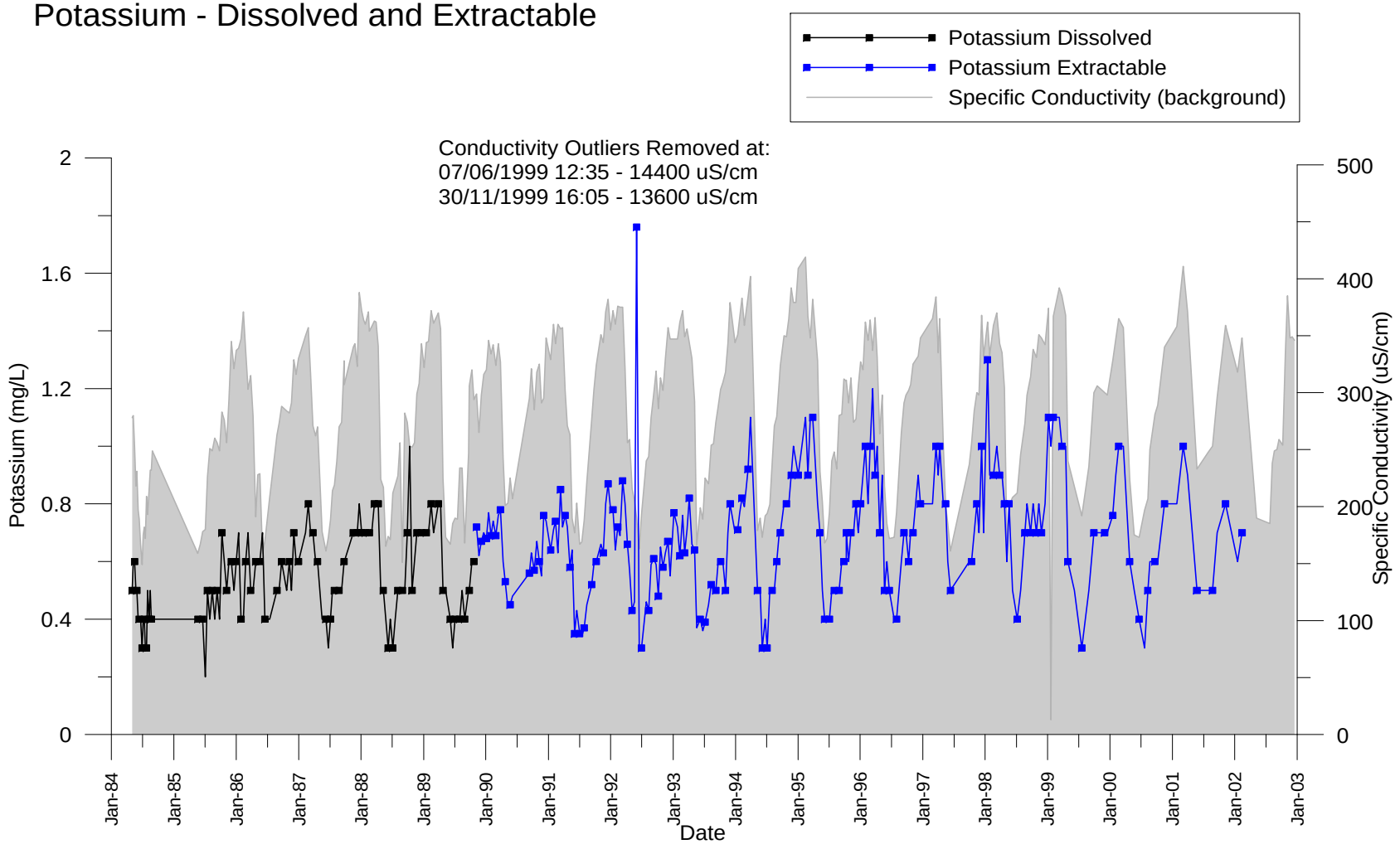

Figure 67
Kootenay River near Fenwick Station
Residue Filterable

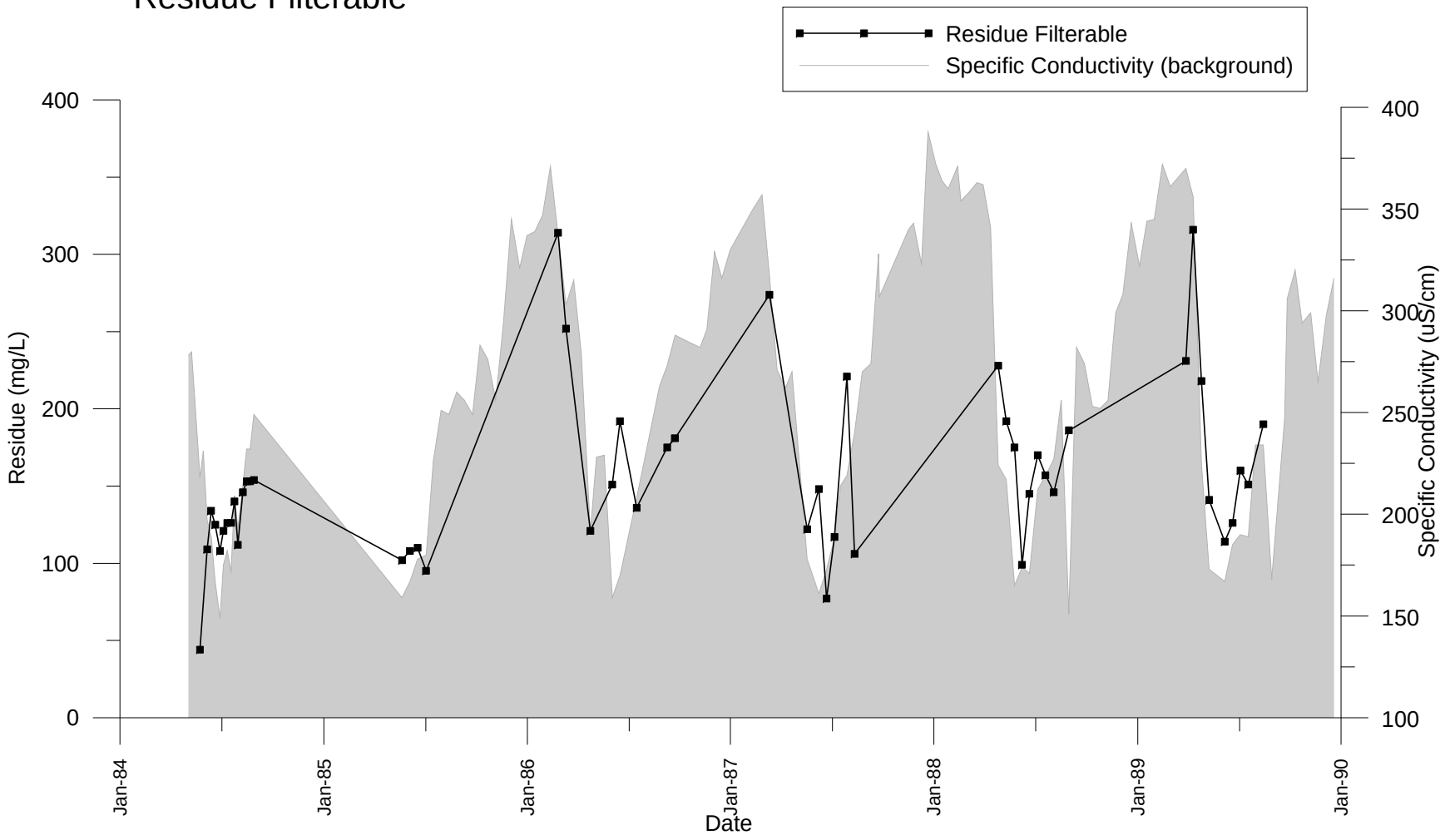

Figure 68
Kootenay River near Fenwick Station
Residue - Fixed Filterable

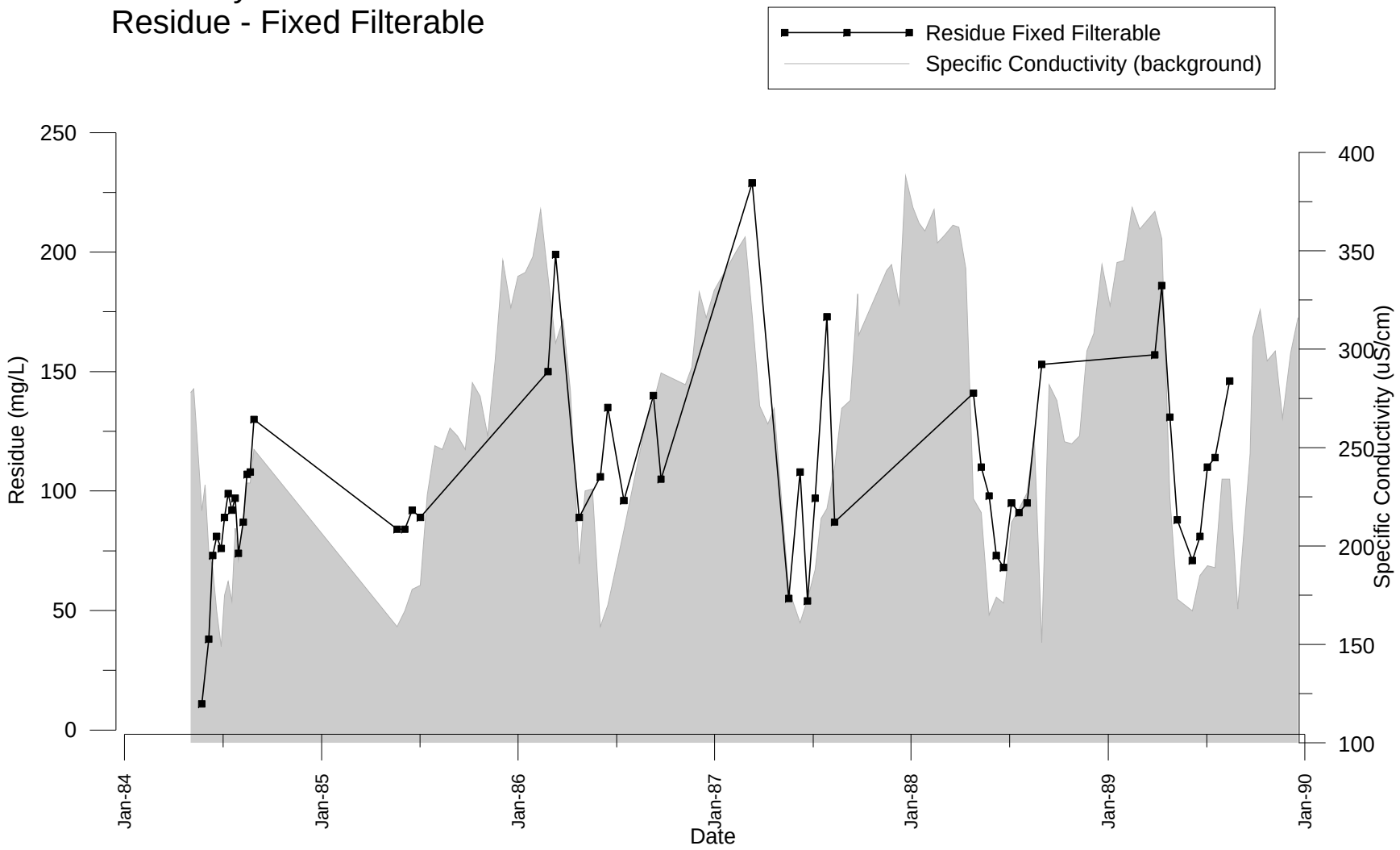

Figure 69
Kootenay River near Fenwick Station
Residue - Fixed Non-Filterable

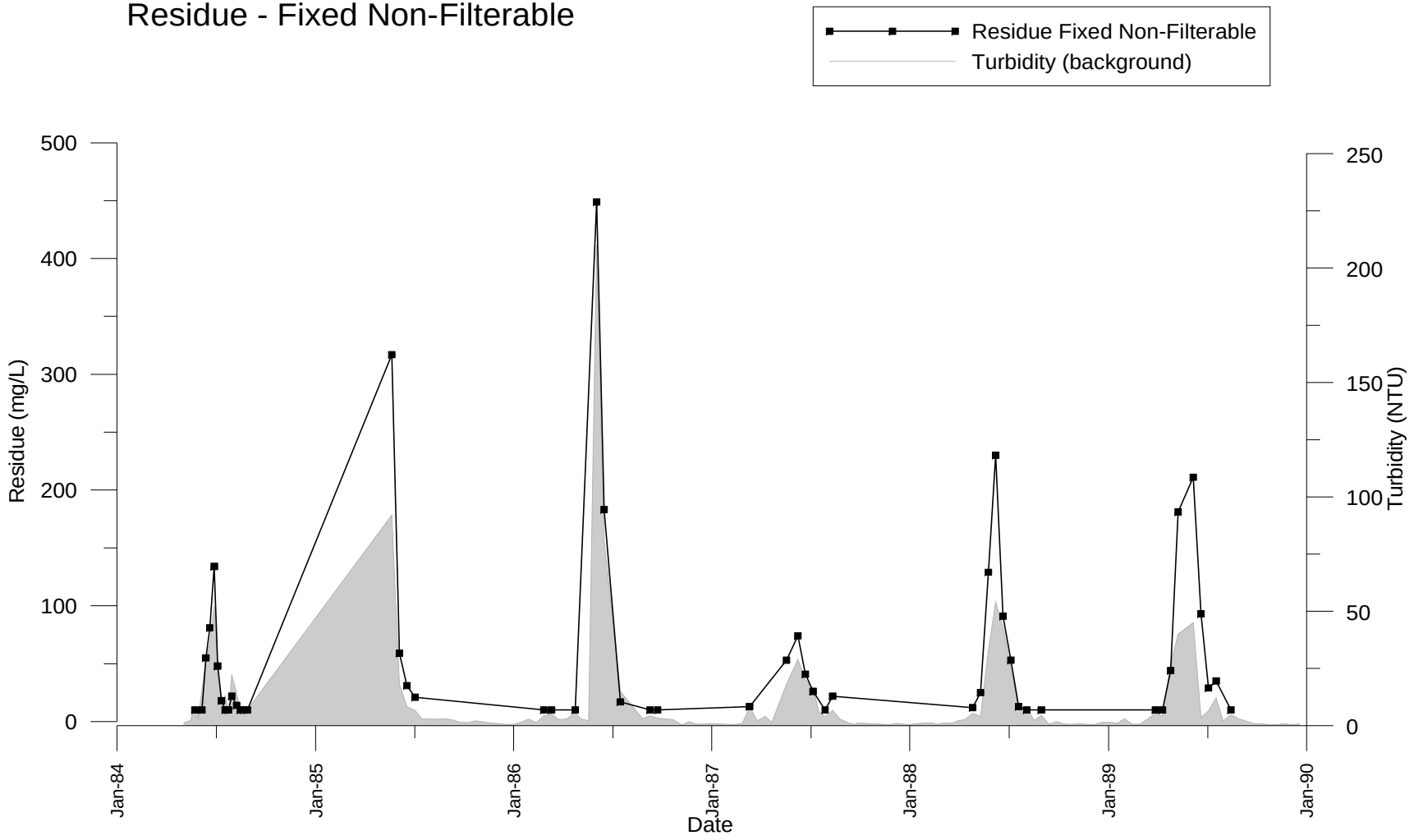

Figure 70
Kootenay River near Fenwick Station
Residue - Non-Filterable

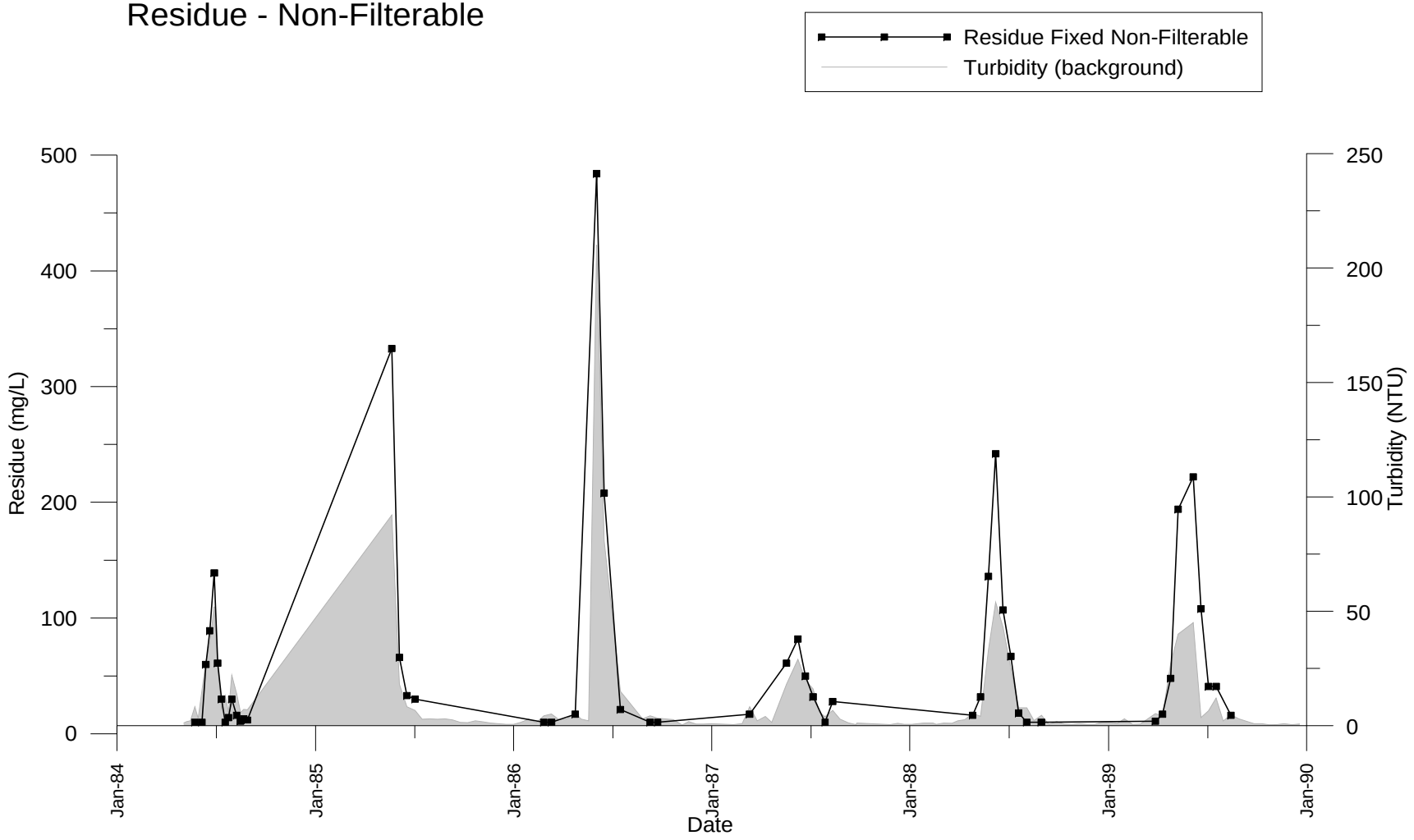

Figure 71
Kootenay River near Fenwick Station
Rubidium - Total and Extractable

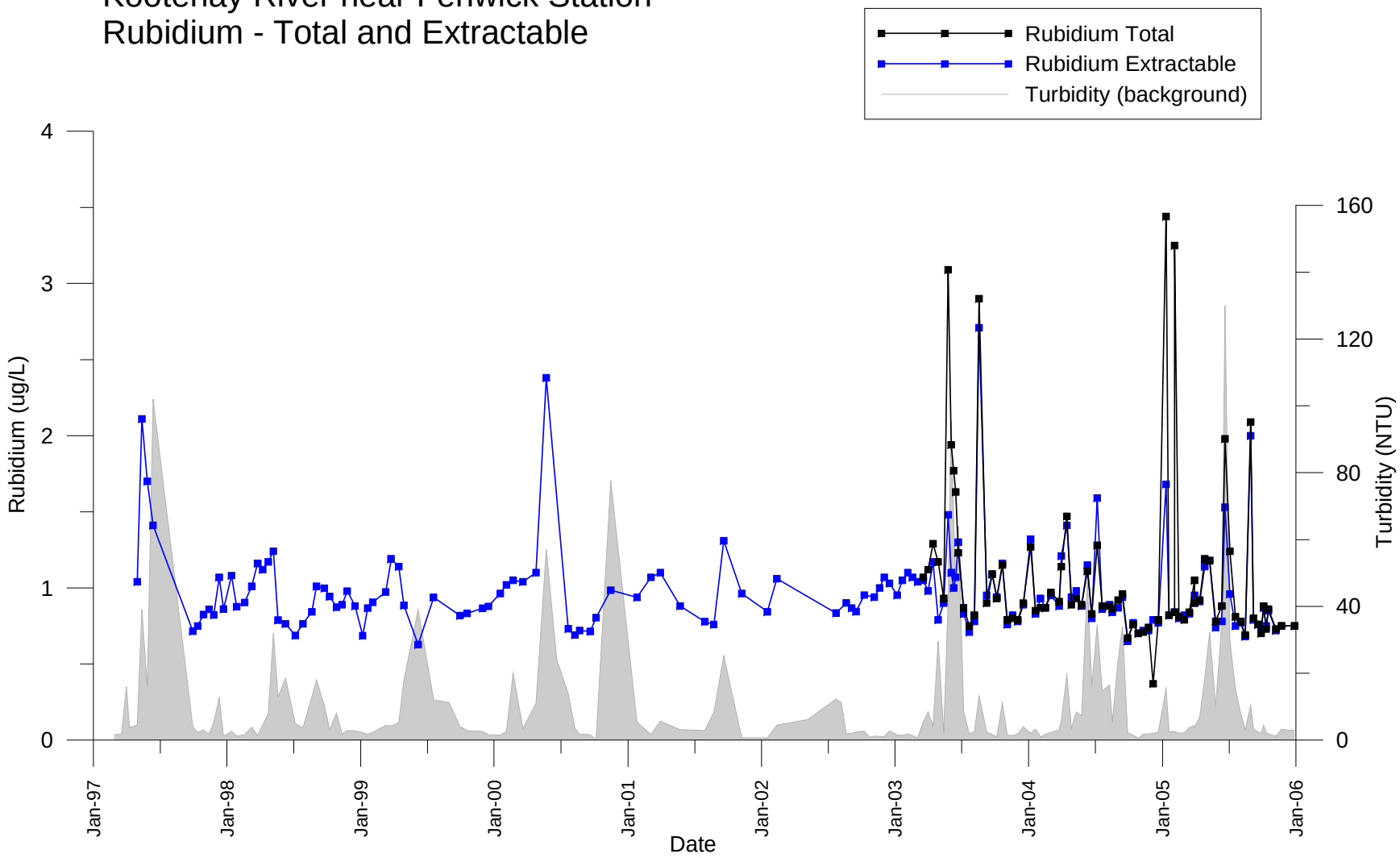

Figure 72
Kootenay River near Fenwick Station
Selenium - Total and Extractable
1984 - 2005

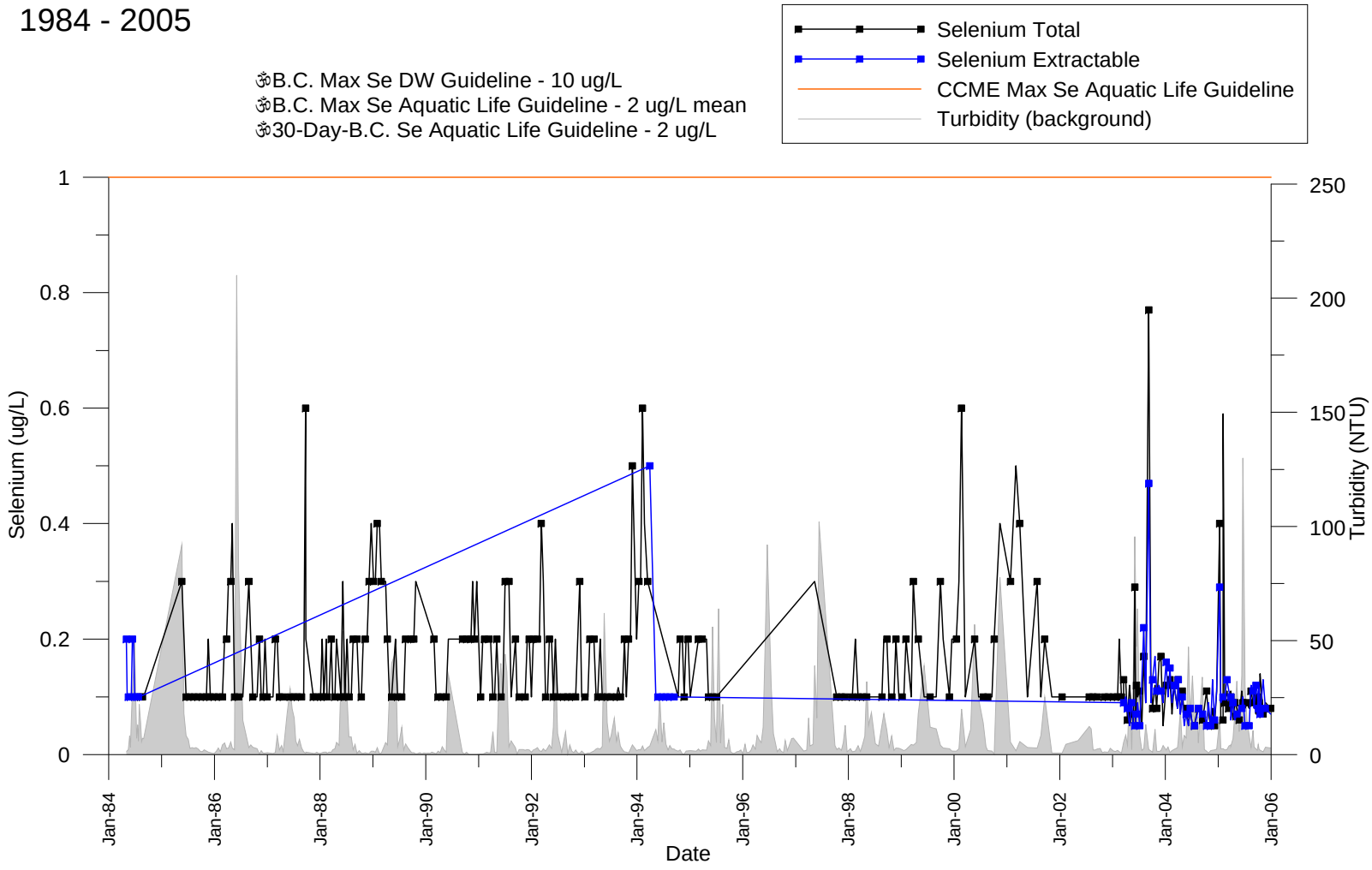

Figure 73
Kootenay River near Fenwick Station
Selenium - Total and Extractable
2003 - 2005

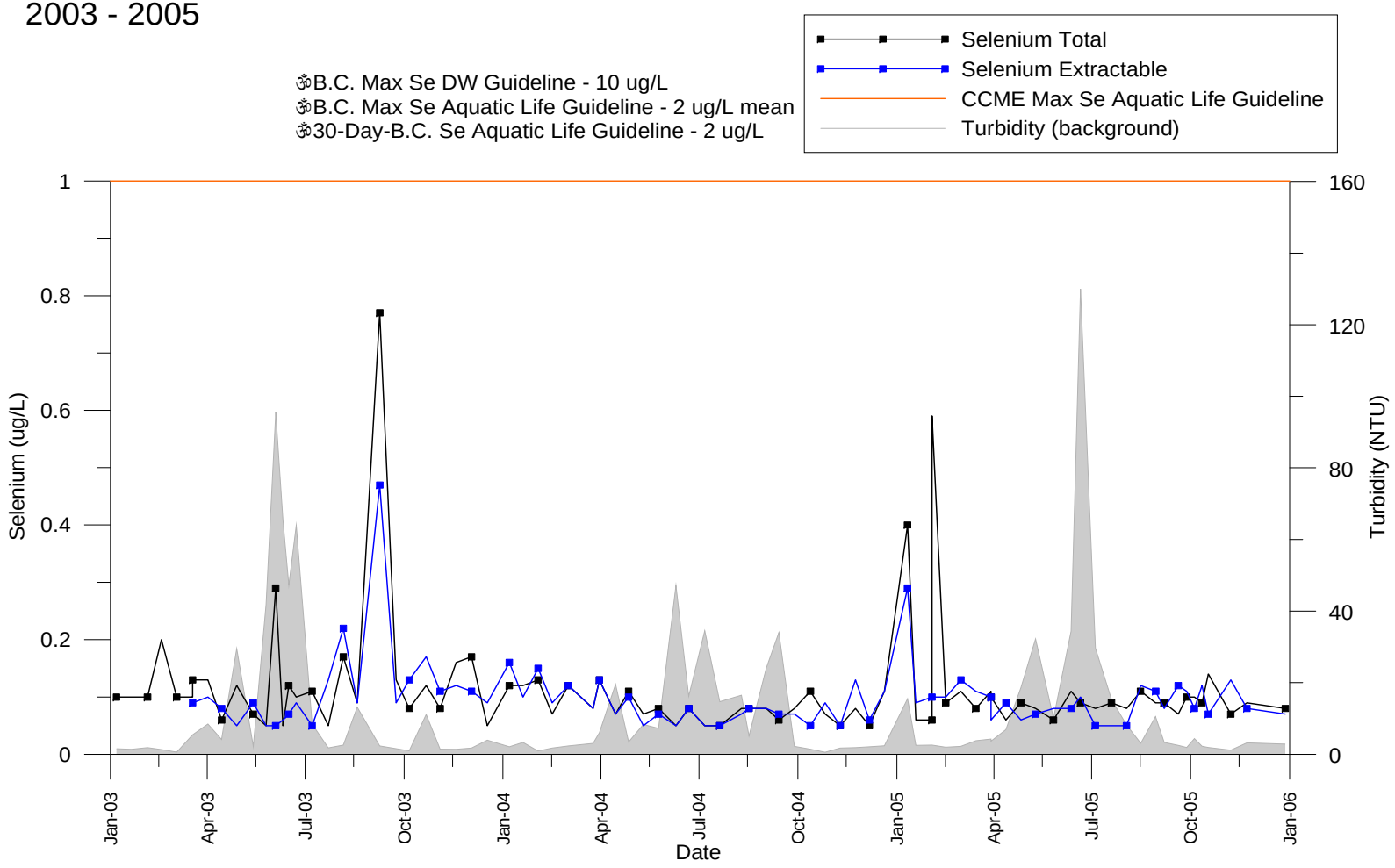

Figure 74
Kootenay River near Fenwick Station
Silica - Dissolved and Reactive

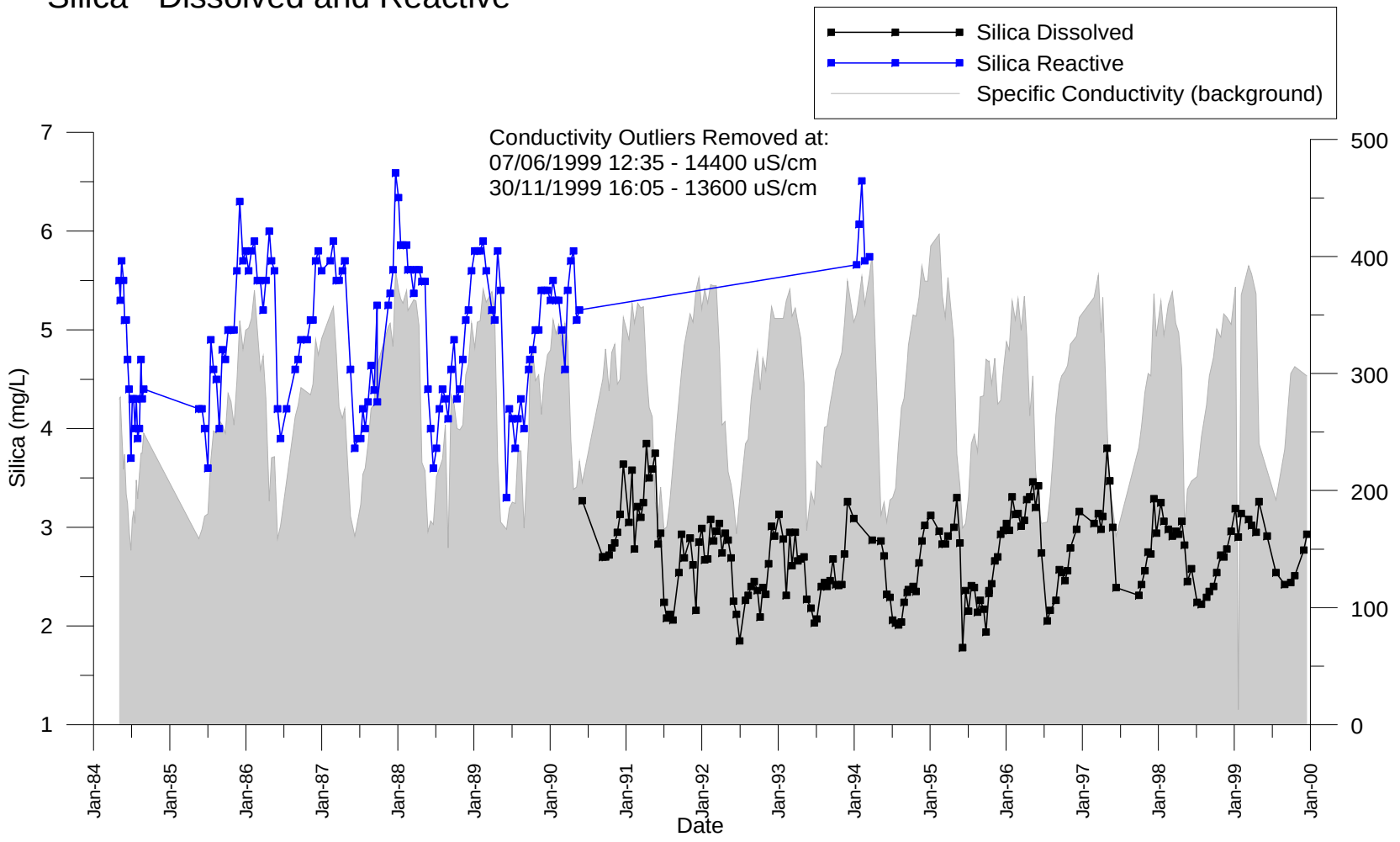

Figure 75
Kootenay River near Fenwick Station
Silicon - Extractable

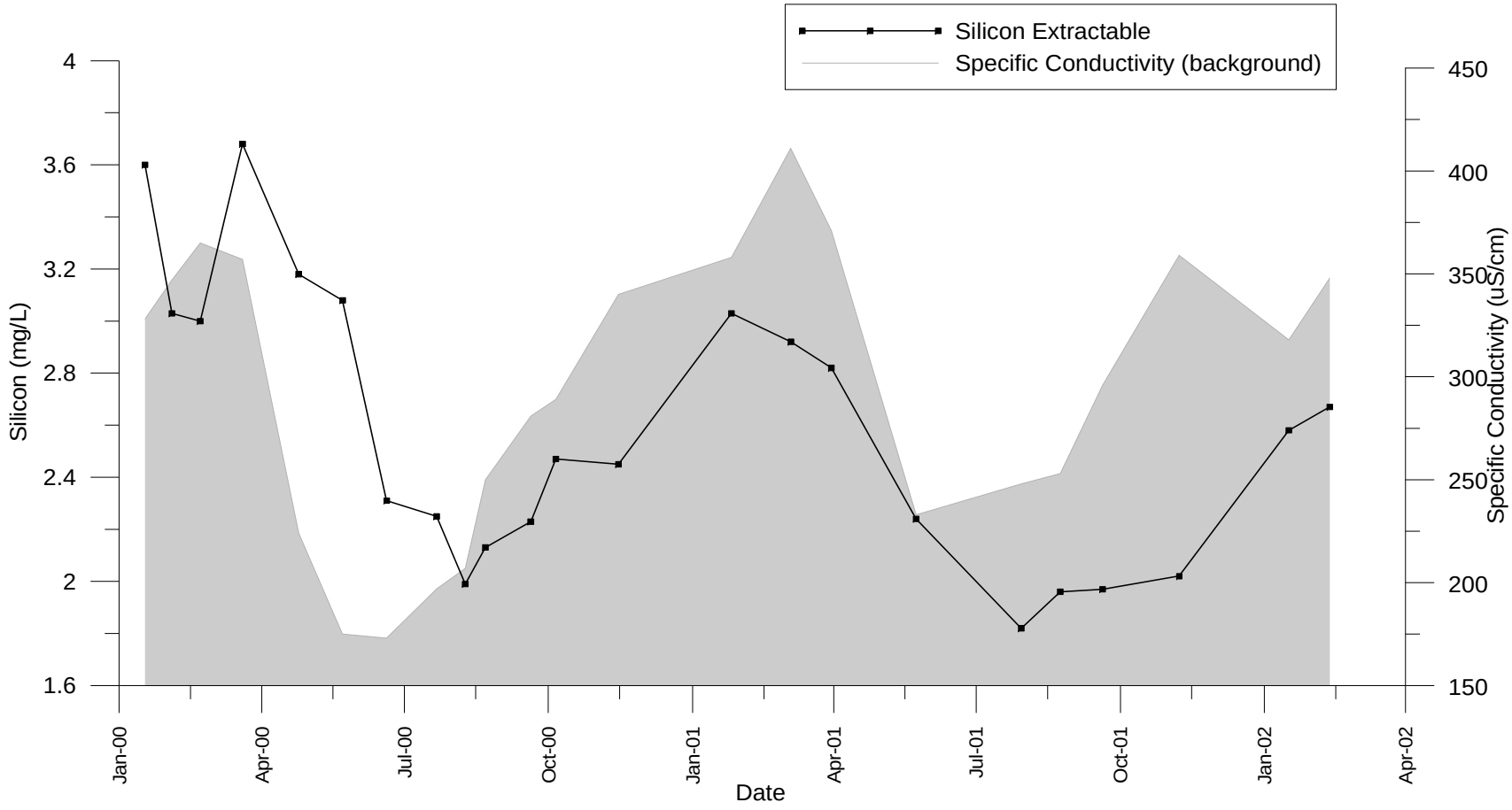

Figure 76
Kootenay River near Fenwick Station
Silver - Total and Extractable
1996 - 2006

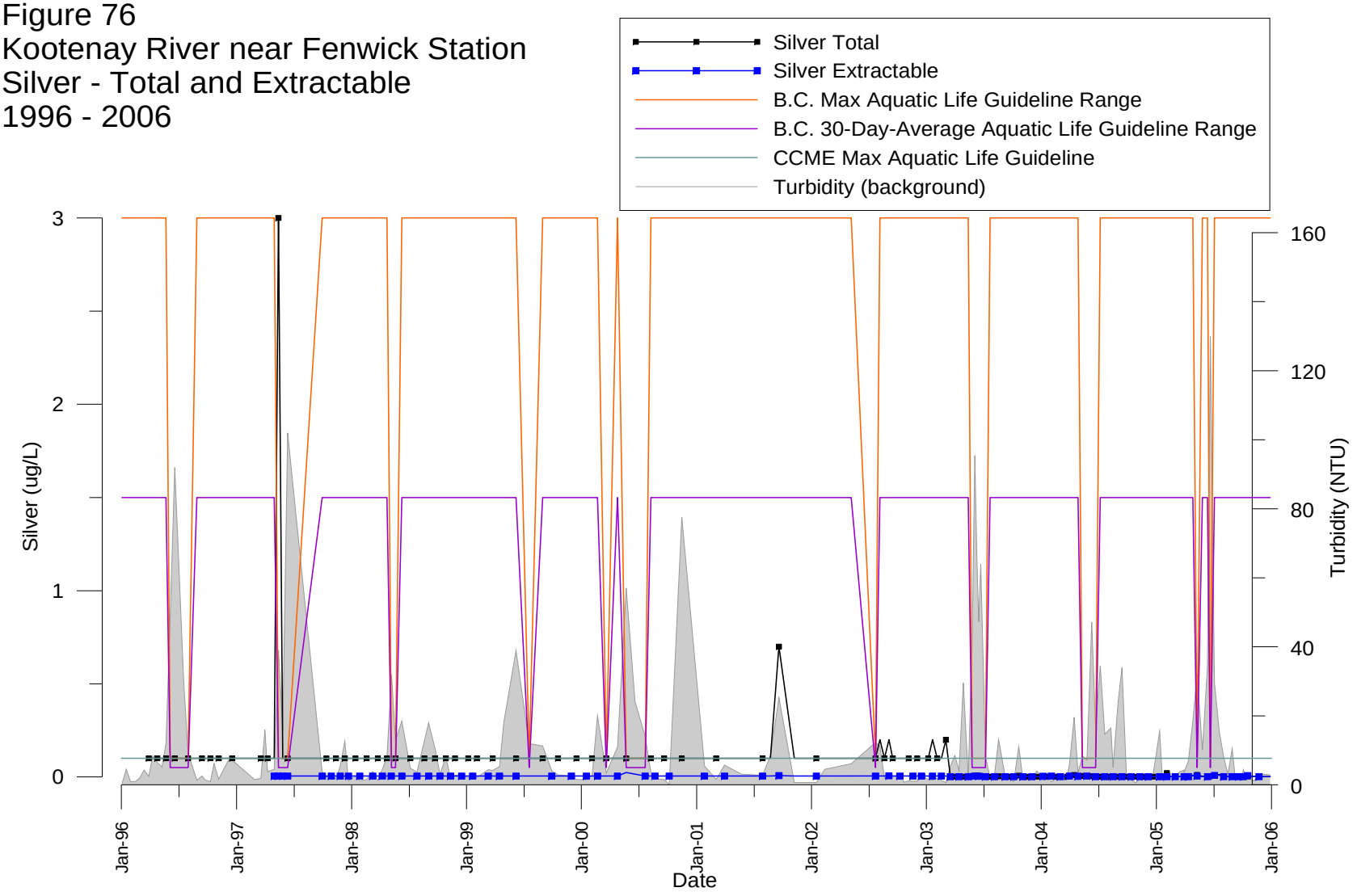

Figure 77
Kootenay River near Fenwick Station
Silver - Total and Extractable
2003 - 2006

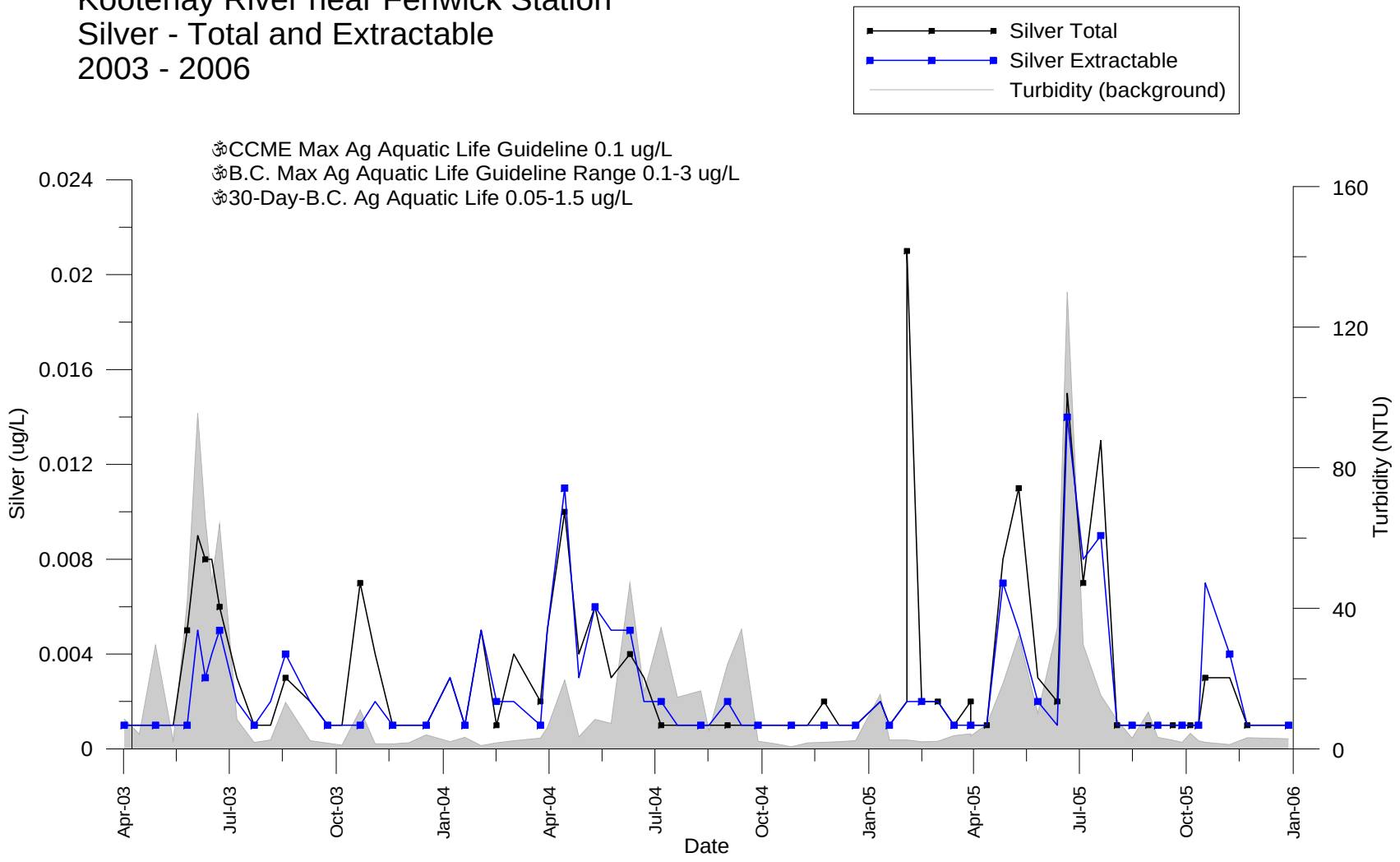

Figure 78
Kootenay River near Fenwick Station
Sodium - Dissolved and Extractable

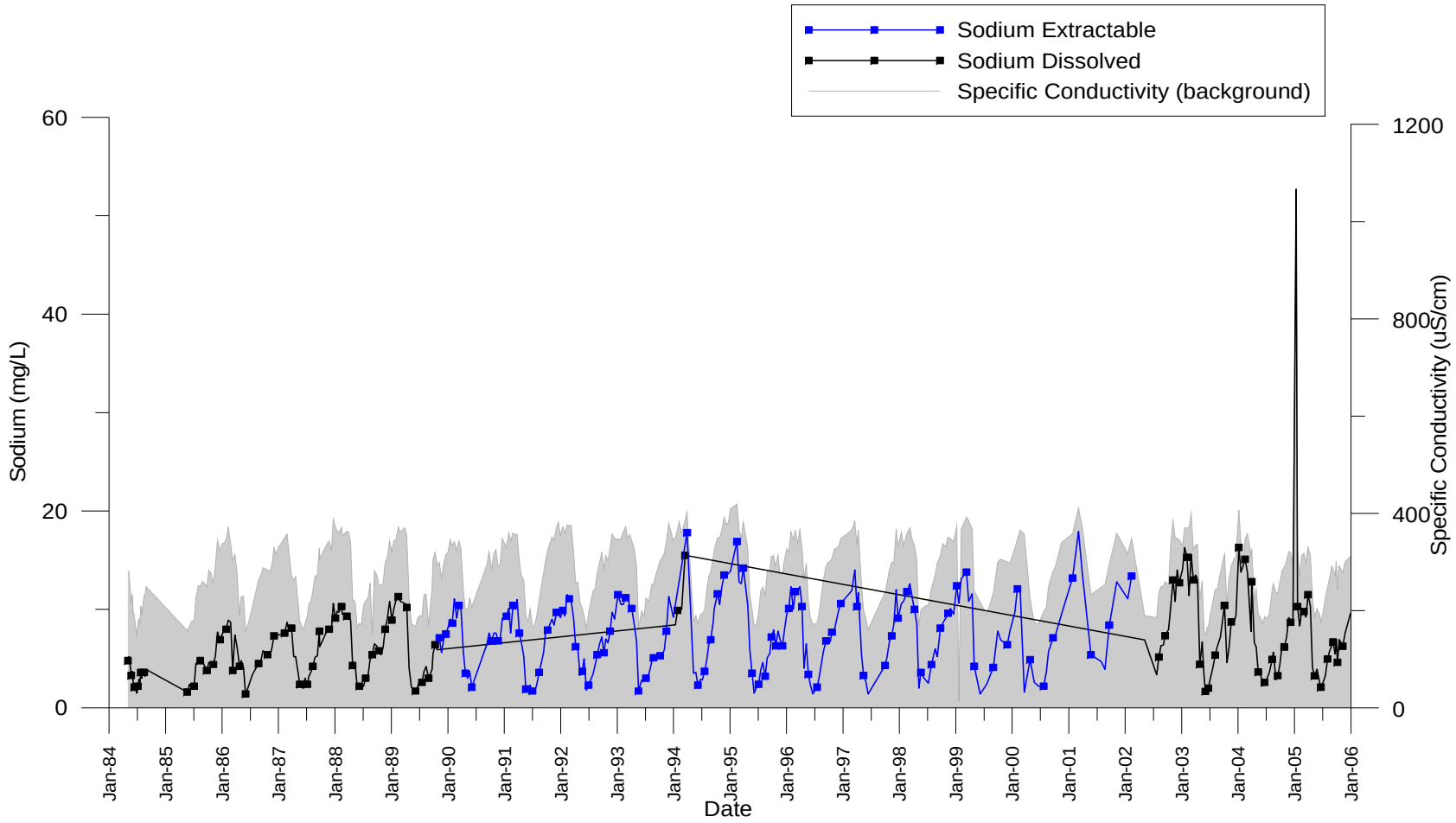

Figure 79
Kootenay River near Fenwick Station
Specific Conductivity

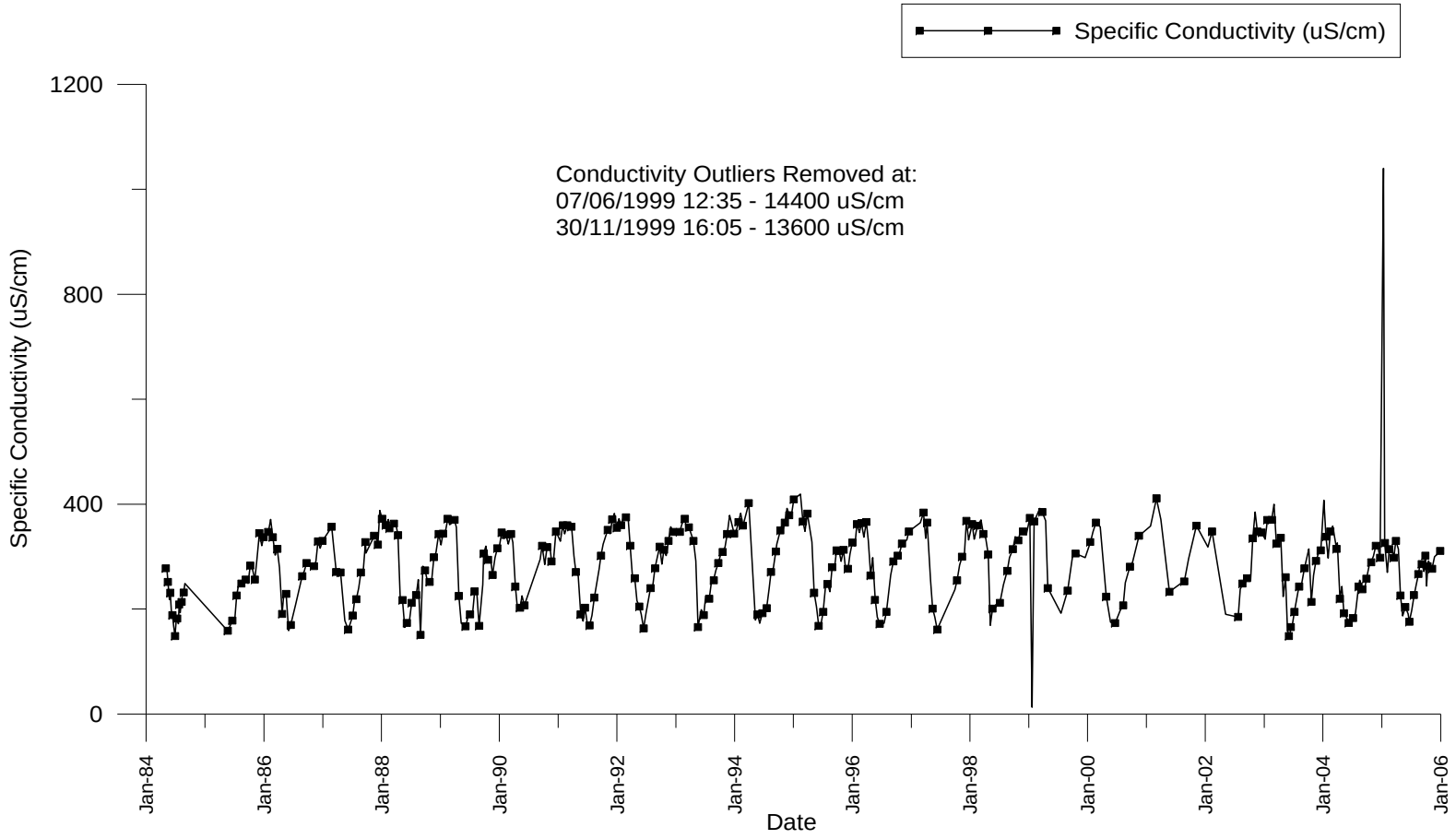

Figure 80
Kootenay River near Fenwick Station
Strontium - Total and Extractable

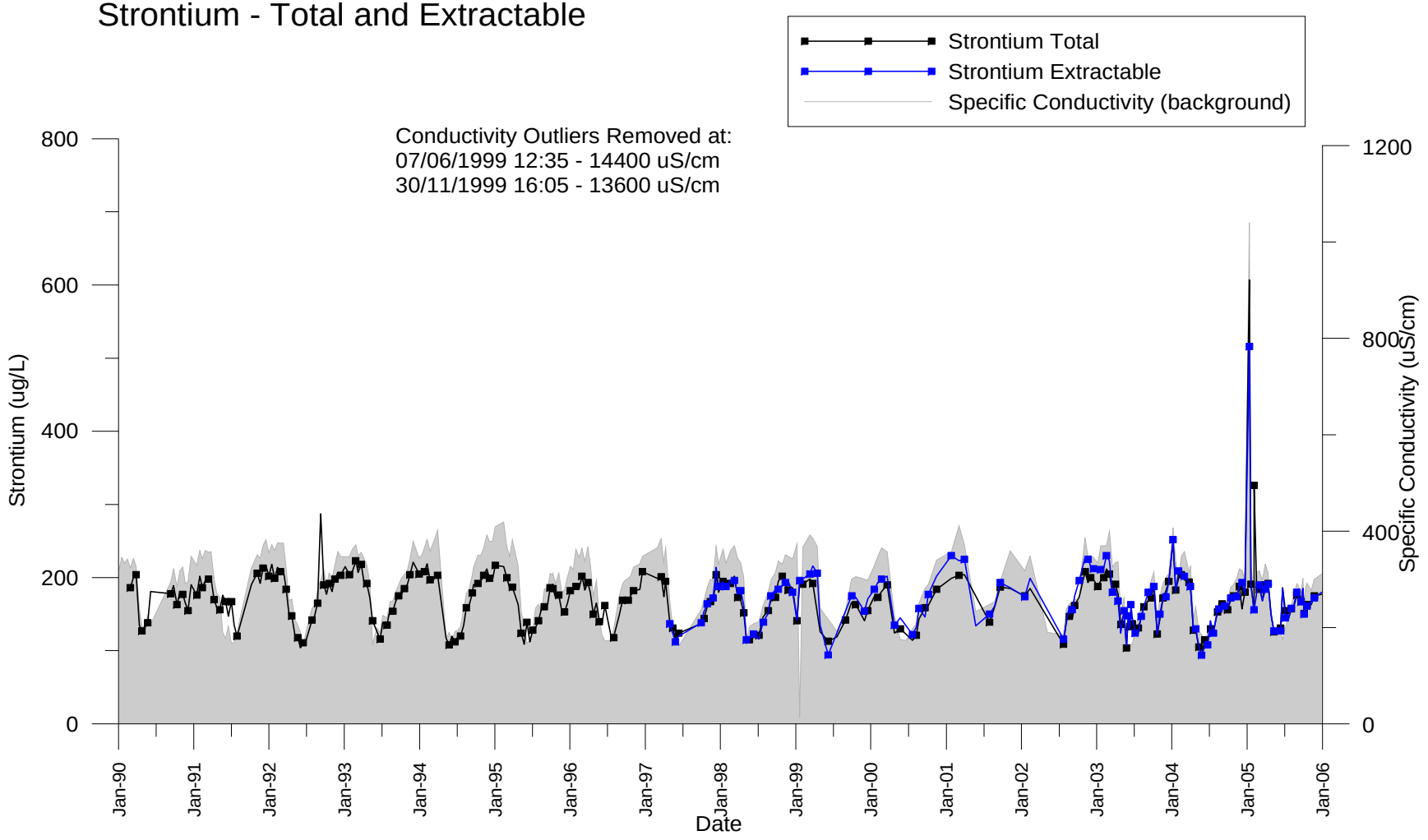

Figure 81
Kootenay River near Fenwick Station
Strontium - Total and Extractable
1997 - 2006

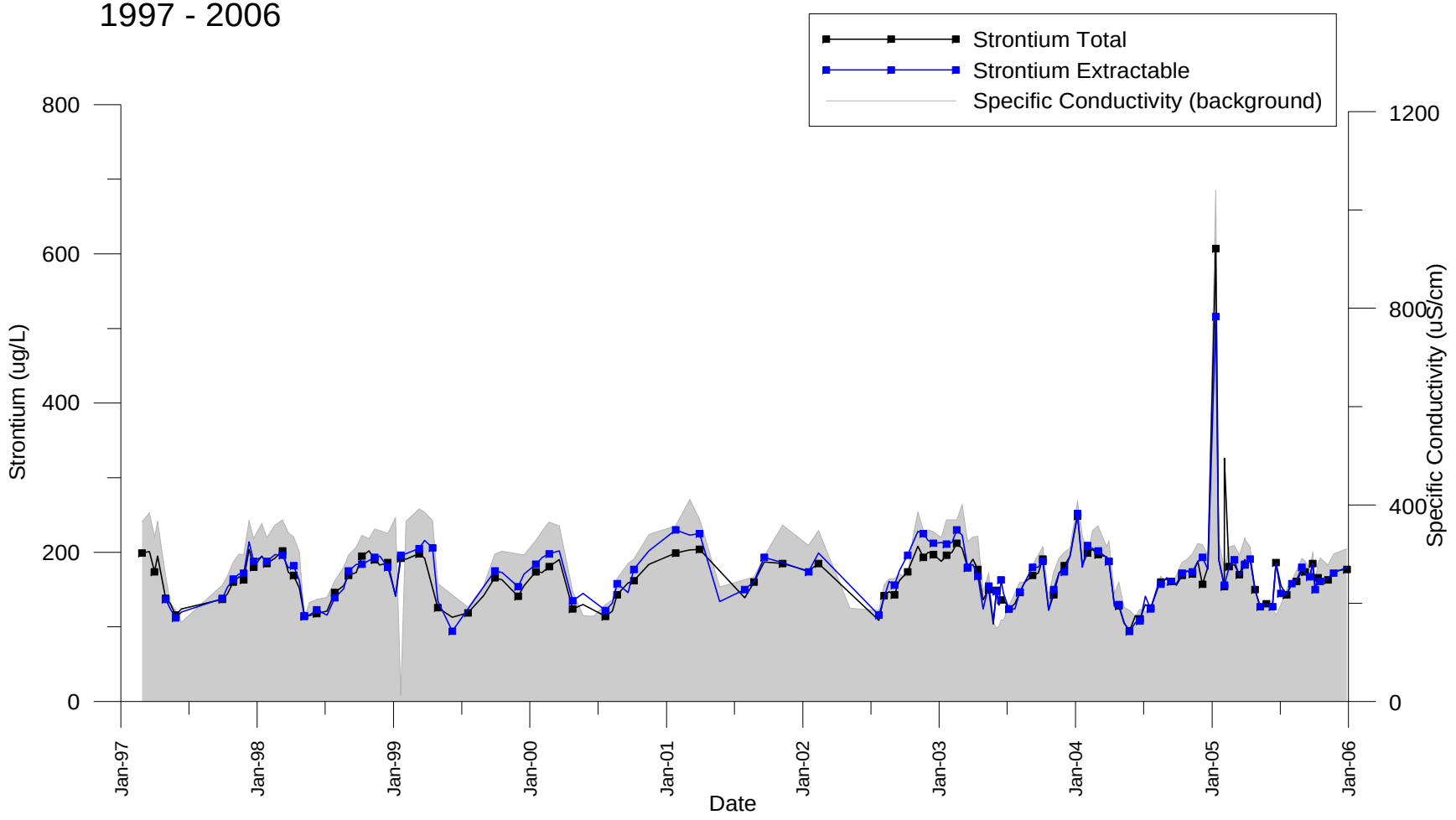

Figure 82
Kootenay River near Fenwick Station
Sulphate - Dissolved

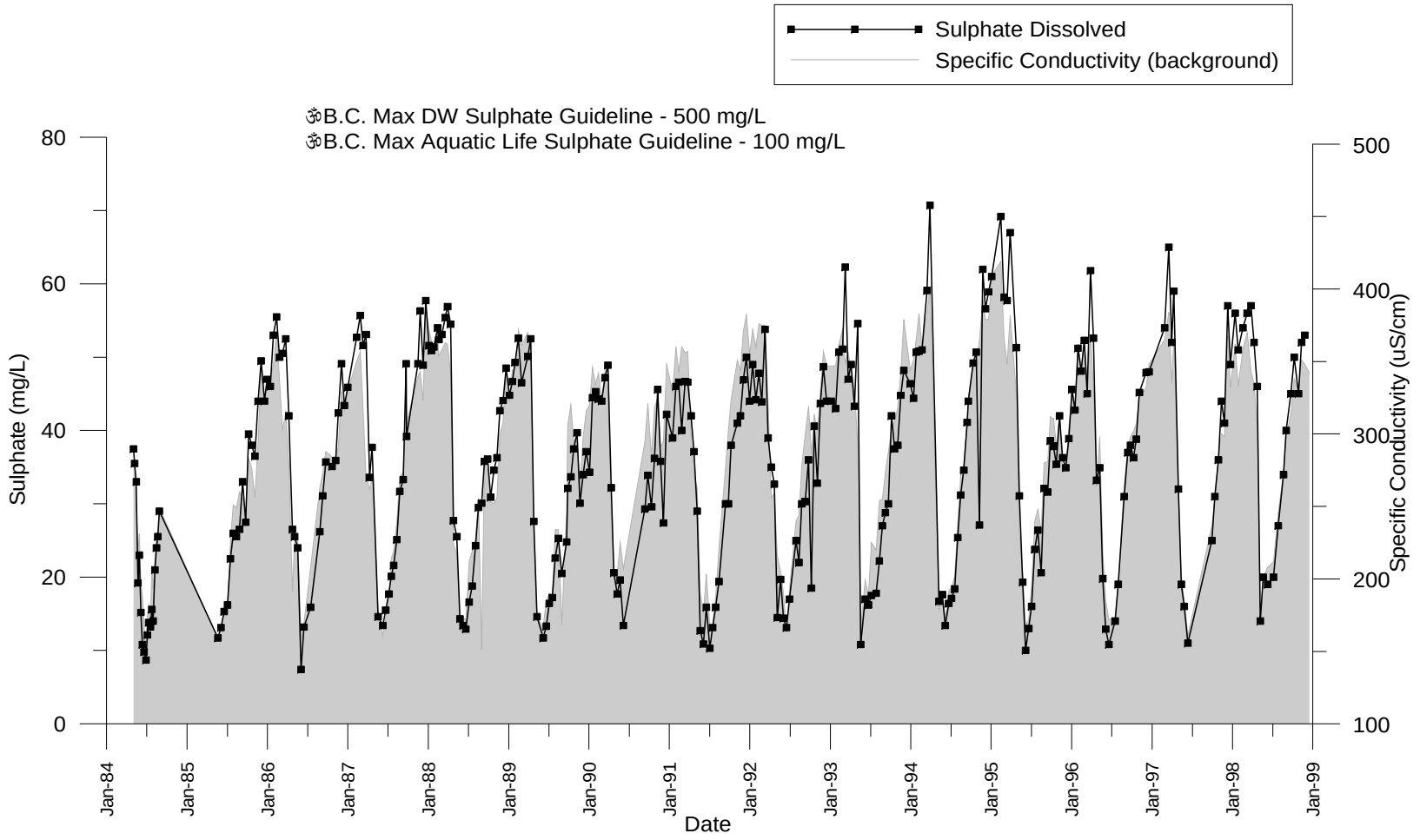

Figure 83
Kootenay River near Fenwick Station
Temperature - Air and Water

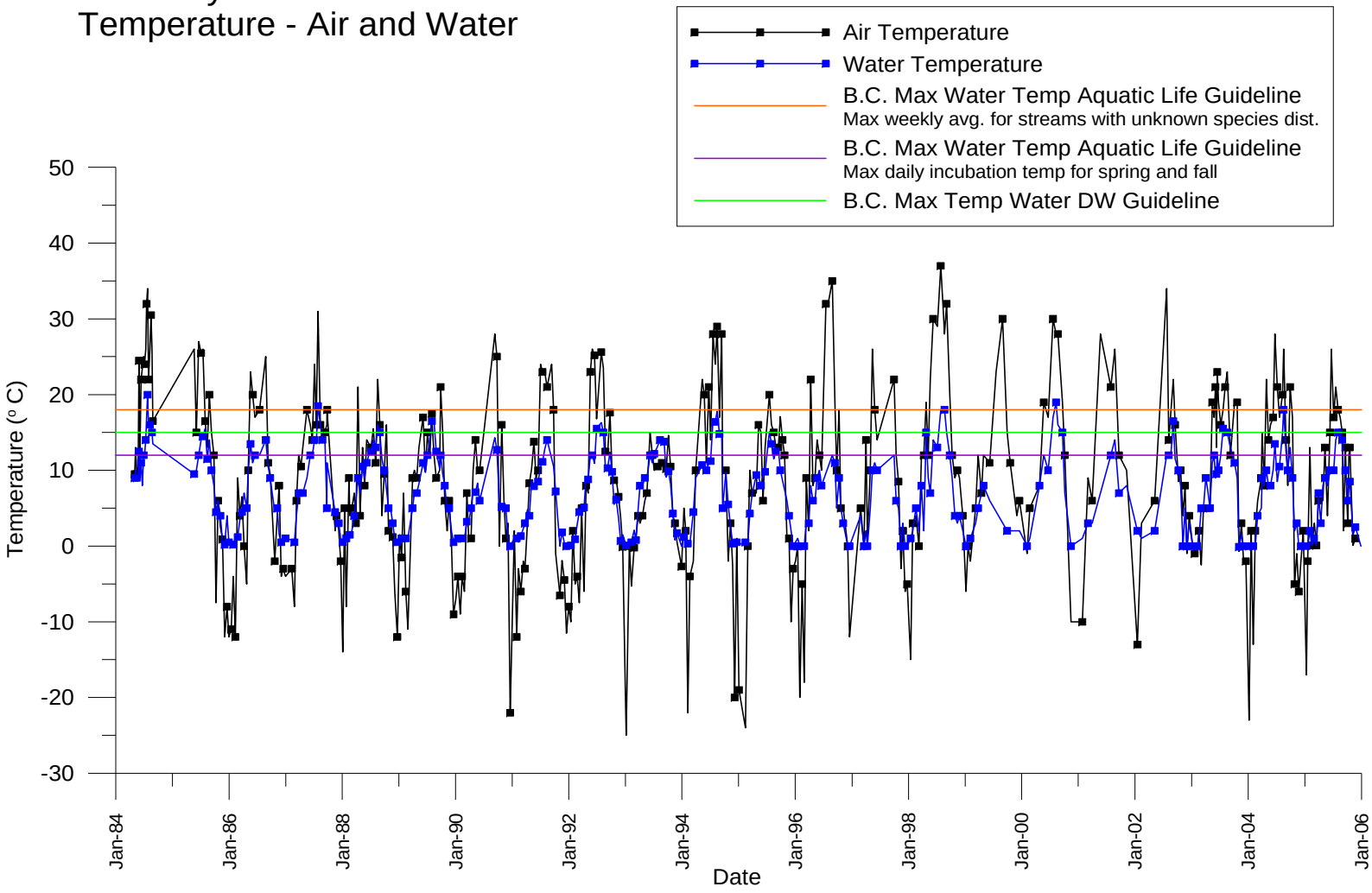

Figure 84
Kootenay River near Fenwick Station
Thallium - Total and Extractable
1997 - 2006

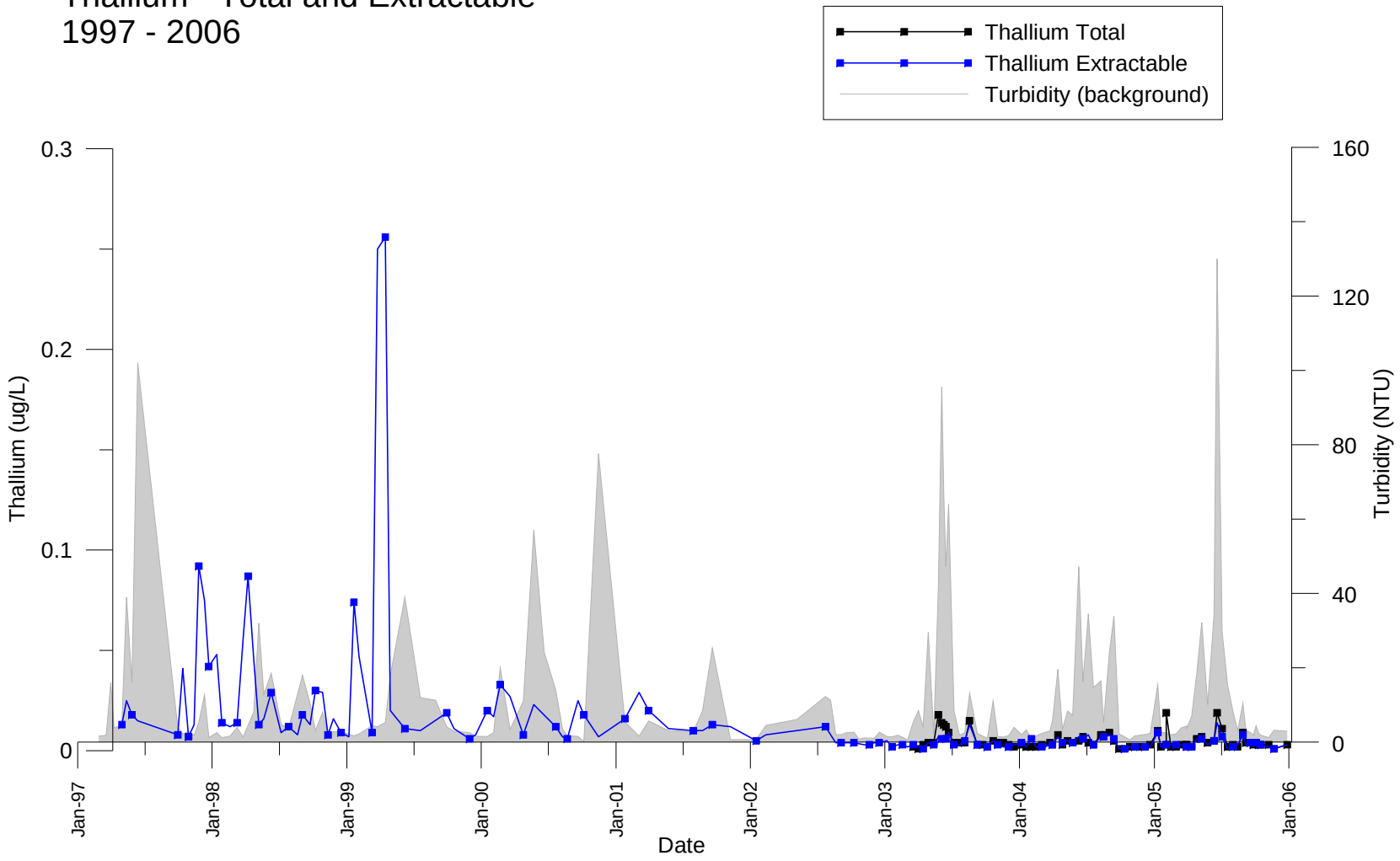

Figure 85
Kootenay River near Fenwick Station
Thallium - Total and Extractable
2003 - 2006

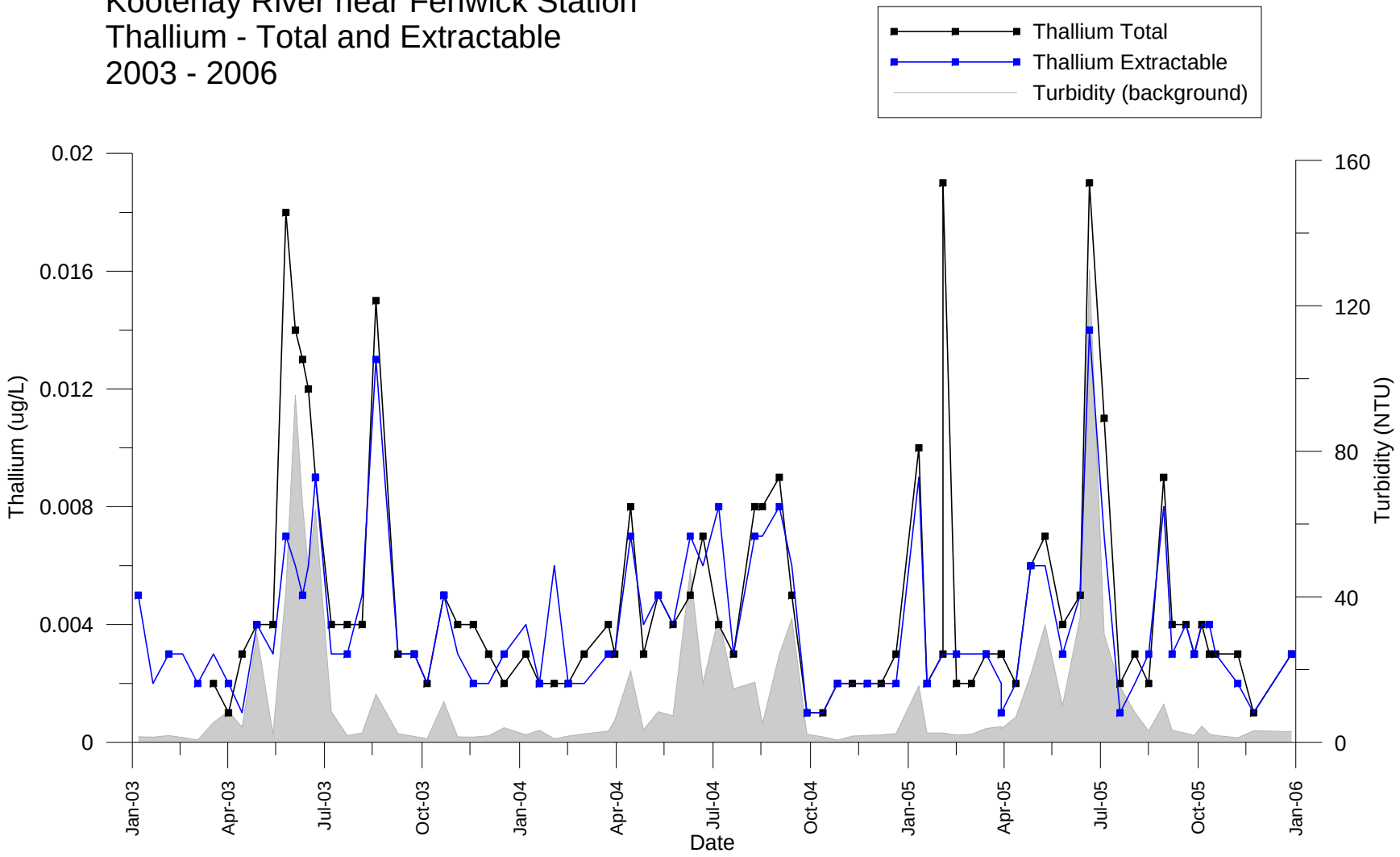

Figure 86
Kootenay River near Fenwick Station
Tin - Total and Extractable
2004 - 2006

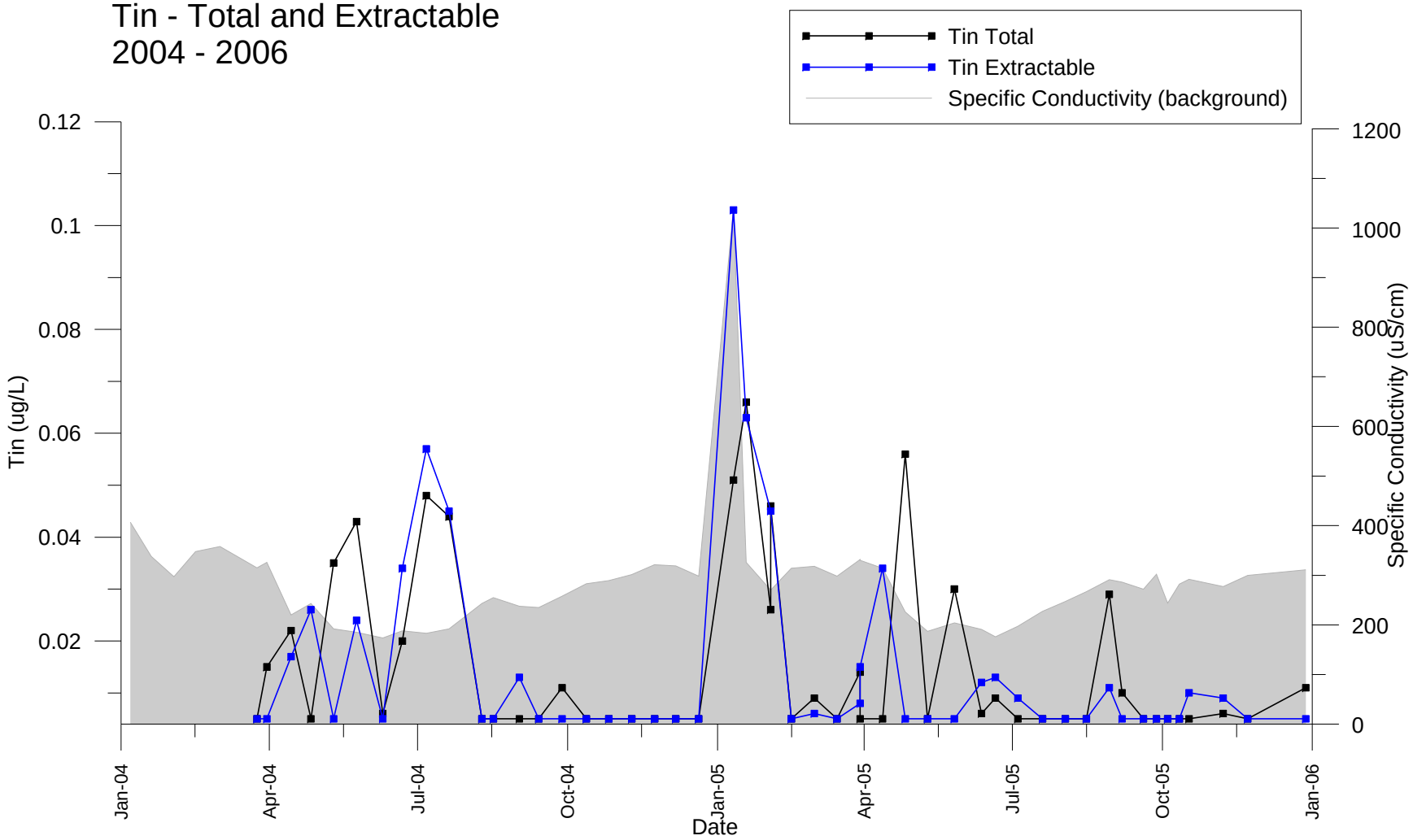

Figure 87
Kootenay River near Fenwick Station
Tin - Total and Extractable

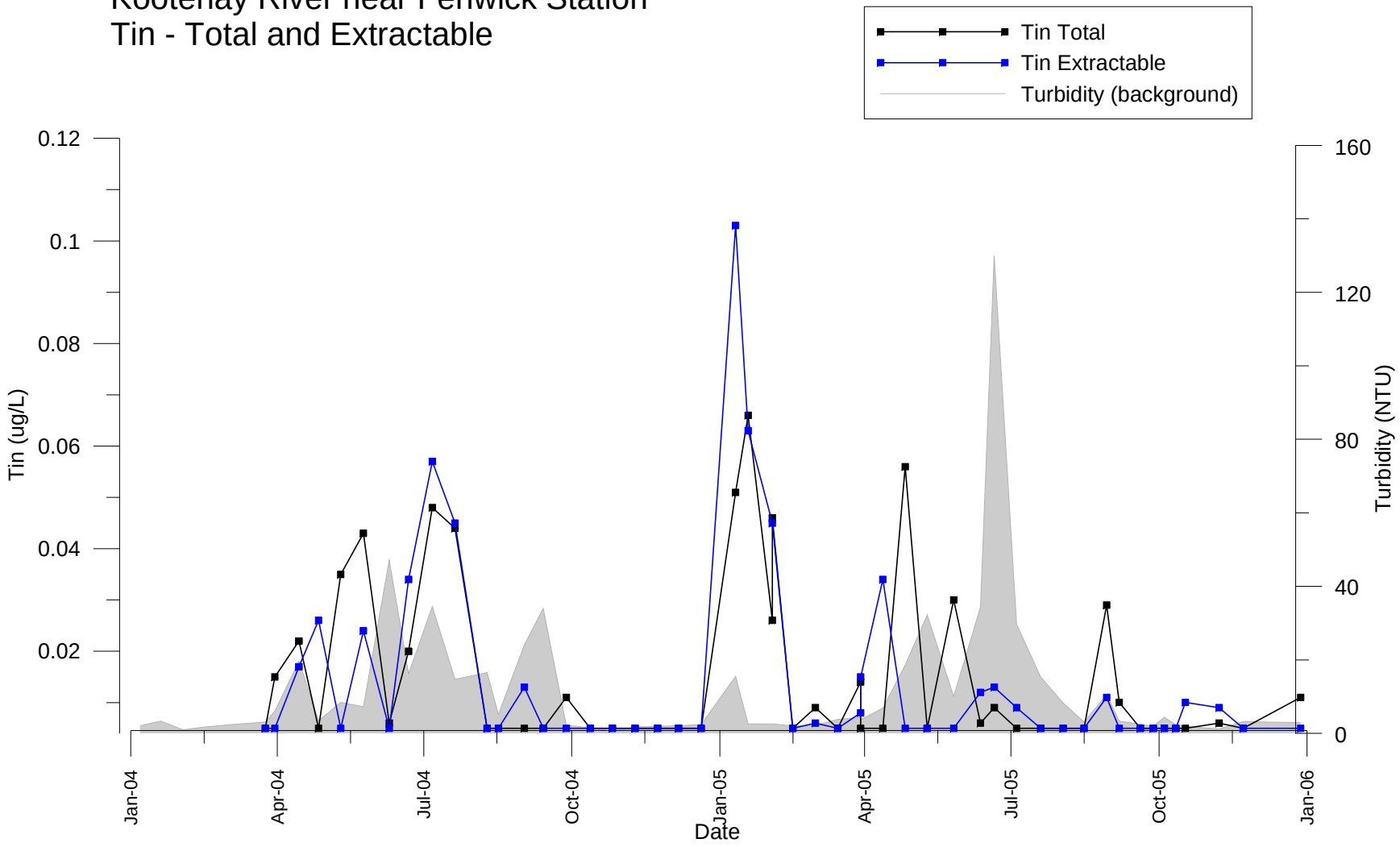

Figure 88
Kootenay River near Fenwick Station
Turbidity

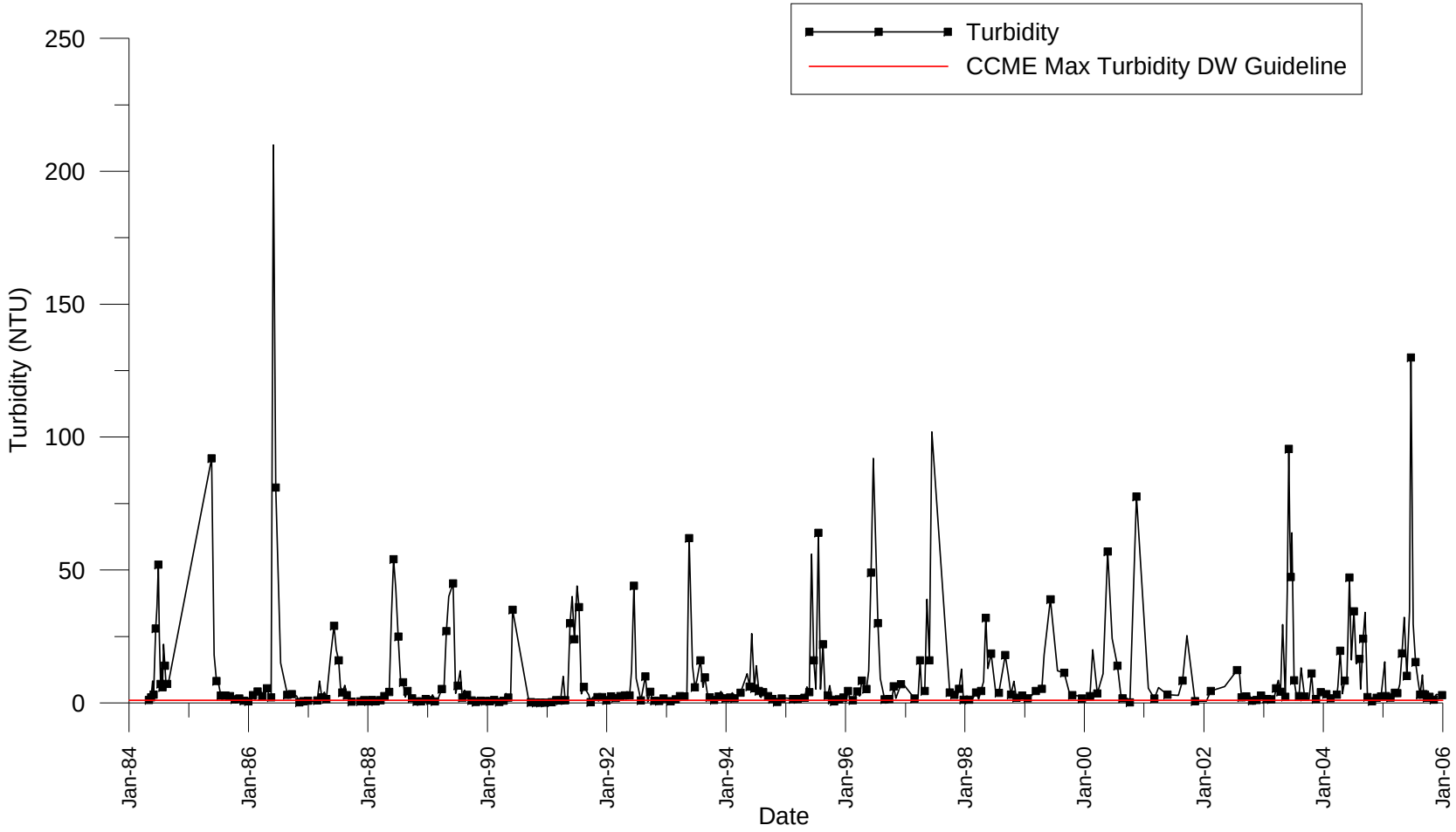

Figure 89
Kootenay River near Fenwick Station
Uranium - Total and Extractable

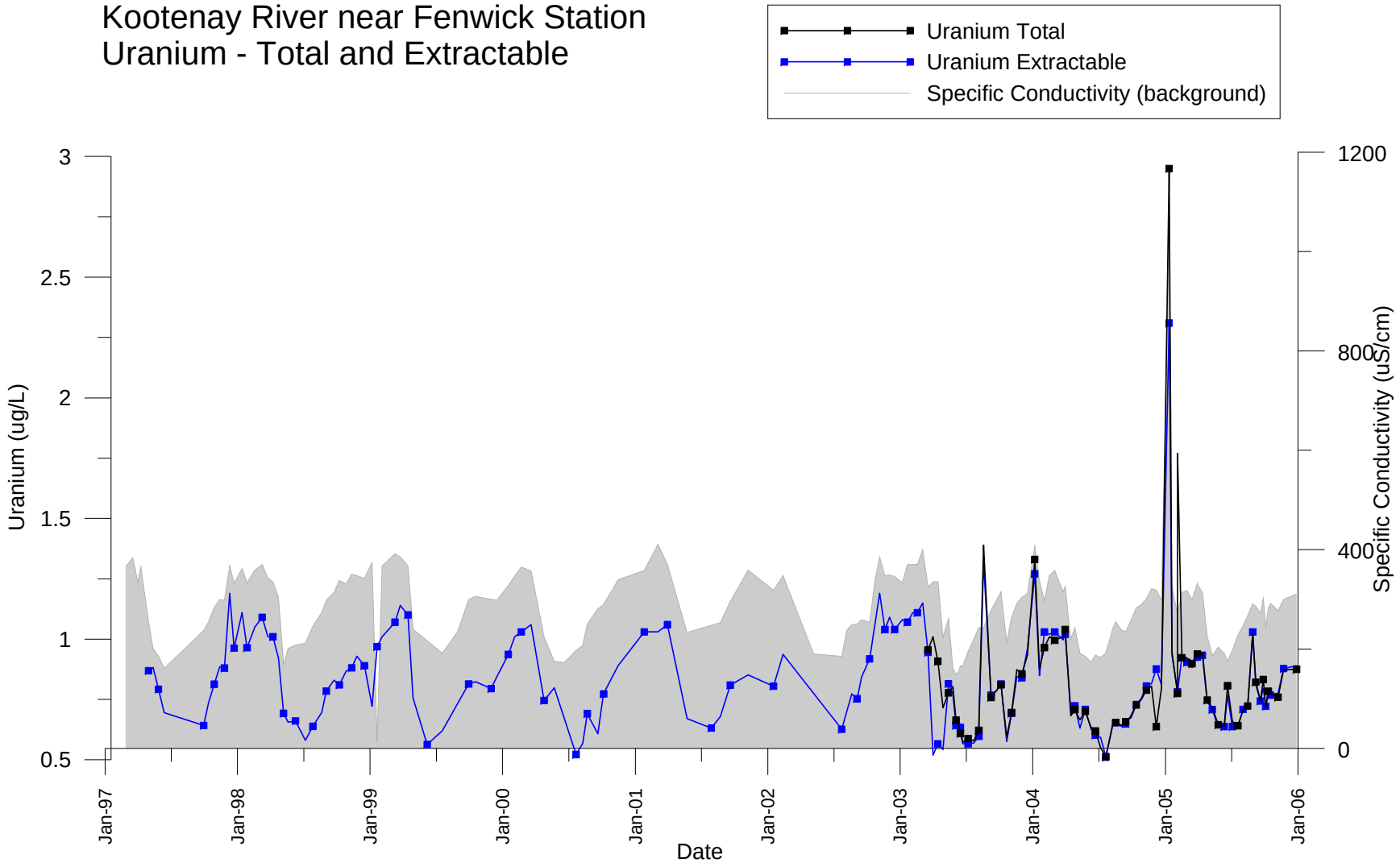

Figure 90
Kootenay River near Fenwick Station
Vanadium - Total and Extractable
1990 - 2006

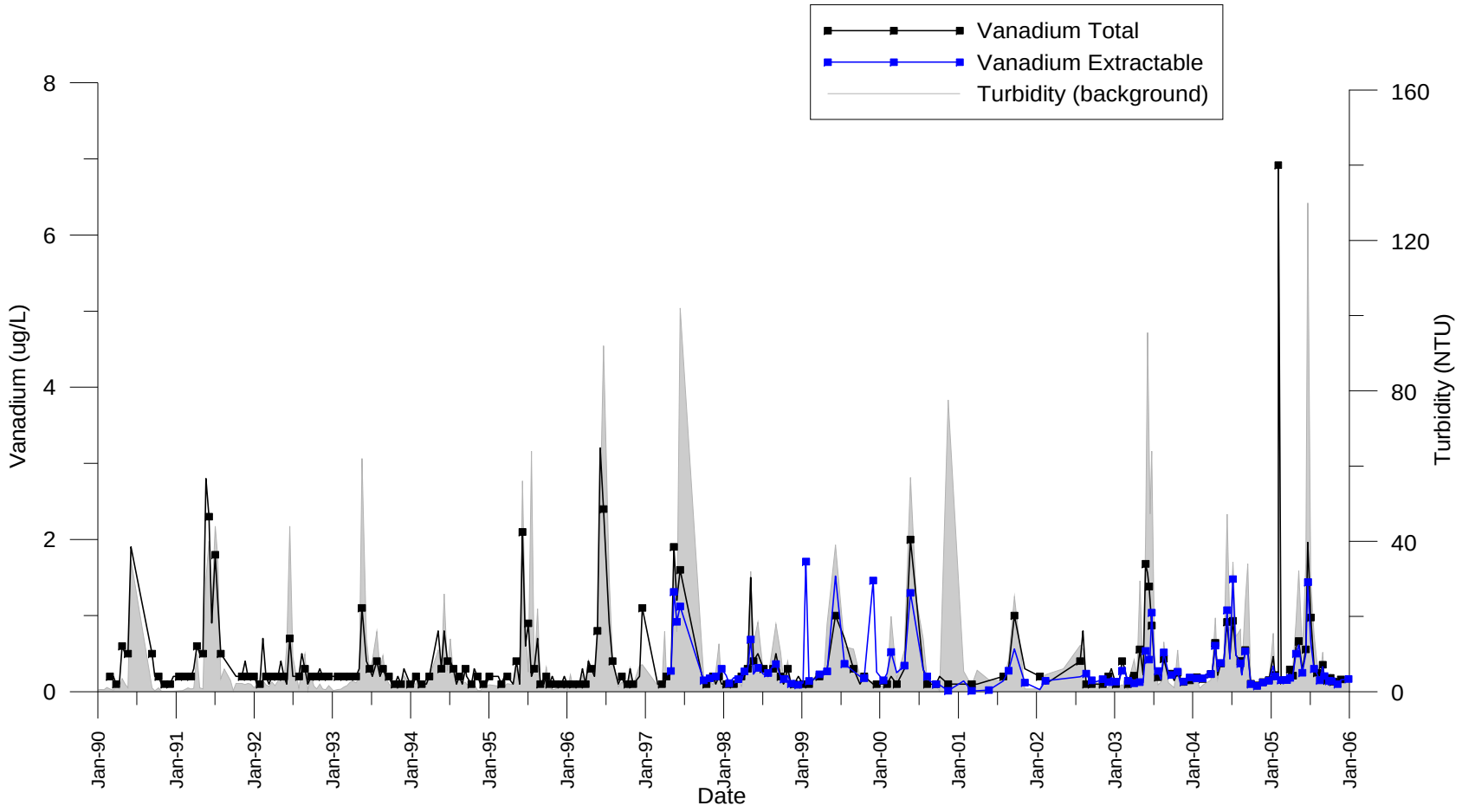

Figure 91
Kootenay River near Fenwick Station
Vanadium - Total and Extractable
1997 - 2006

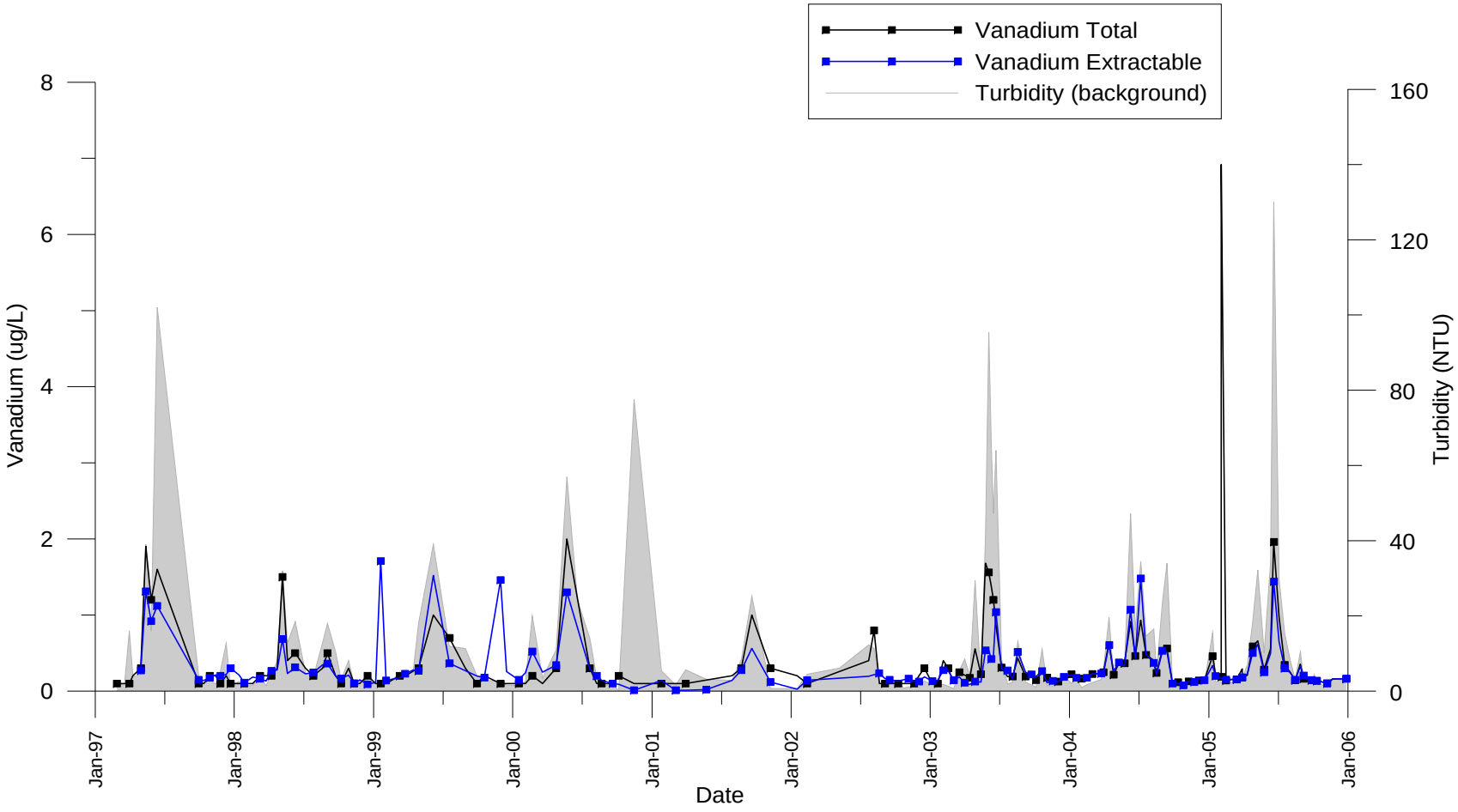

Figure 92
Kootenay River near Fenwick Station
Zinc - Total and Extractable
1984 - 2005

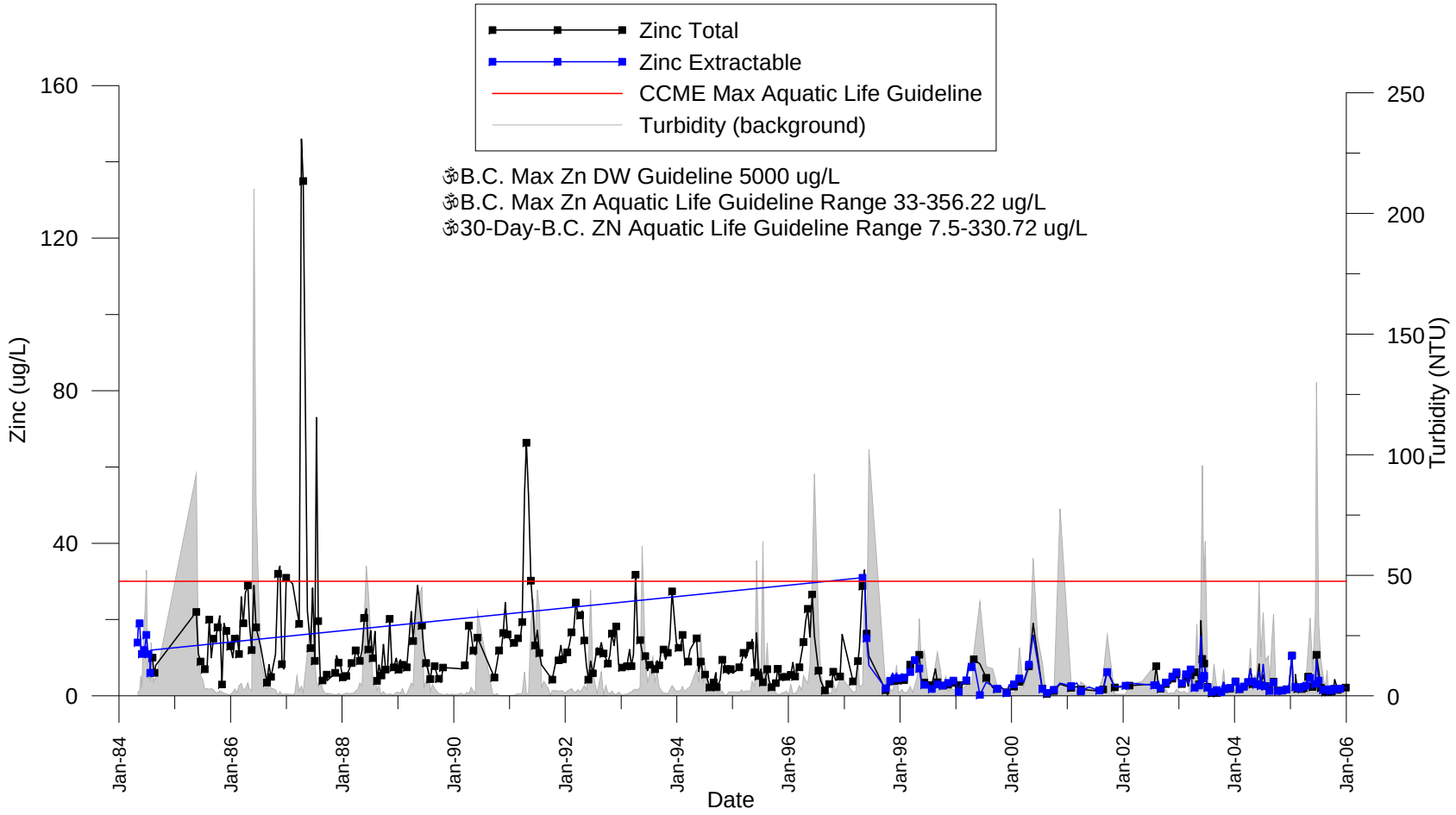

Figure 93
Kootenay River near Fenwick Station
Zinc - Total and Extractable
1997 - 2006