CANADA – BRITISH COLUMBIA
WATER QUALITY MONITORING AGREEMENT

WATER QUALITY ASSESSMENT OF Elk River AT SPARWOOD (2002 – 2005)

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

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Environment Canada **Environnement Canada**

BRITISH COLUMBIA
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EXECUTIVE SUMMARY

The Elk River watershed is located in the southeast corner of British Columbia, and drains 4450 km^2 of the Rocky Mountains to the Kootenay River/Lake Koocanusa about 20 km upstream from the border with the United States. It is the most heavily-fished river in the Kootenays, with large populations of westslope cutthroat trout, bull trout and whitefish. The upper most water quality sampling station on the Elk River is located near Sparwood. This assessment is based on up to four years of water quality data during 2002-2005.

The main human activities in the Elk River watershed are open pit coal mining, forestry, outdoor tourism, and residential and commercial development. The water quality trends identified below have not yet been confirmed by statistical analysis.

CONCLUSIONS

- Selenium concentrations always exceeded both CCME and B.C. guidelines for the protection of aquatic life. These high values are associated with high suspended solids concentrations from active open pit mining.
- Fluoride concentrations may be showing a slight trend to decreasing concentrations; however, a longer period of record is needed to confirm this possible trend.
- Turbidity, fecal coliform and e. coli concentrations exceeded source water protection guidelines for use of the water with disinfection only. This means that the water should have partial treatment to remove both turbidity and improve the removal of bacteria.
- Otherwise, water quality was generally good with only occasional values exceeding guidelines for dissolved cadmium 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 Elk River at Sparwood since it serves as an upstream station for the Elk River at Elko 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 graphs in this report were prepared by Sacha Wassick of Environment Canada. The draft report was reviewed by Jody Frenette of BC Environment and Andrea Ryan of Environment Canada. Tri-Star Environmental Consulting performed the final edits of the document. 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 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.

Water quality measurements for the Elk River at Sparwood are from samples collected 200 m upstream from the bridge located at the end of the road to Garrett Ready Mix Plant site in Sparwood. Its coordinates are 49.664 N and 114.90 W. The drainage area at this point is about 350 km^2. The data were plotted on a graph over time, along with the relevant water quality guidelines. The graphs were inspected for "environmentally significant" trends – defined as being where the measurements are increasing or decreasing over time and the levels are close to the 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 Elk River drains over 4450 km^2 of the Rocky Mountains to the Kootenay River/Lake Koocanusa about 20 km upstream from the border with the United States. The river is important for fish spawning and rearing, for migrating salmon, and for irrigation, livestock watering, drinking water, and recreation. It is the most heavily-fished river in the Kootenays, with large populations of westslope cutthroat trout, bull trout and whitefish.

Main influences on water quality include open pit coal mining, forestry, outdoor tourism, and residential and commercial development. Large scale coal mining began in the Elk River Valley in 1970 and has since expanded to five major coal mining operations producing over 25 million metric tons of coal each year. The Elk Valley presently contains the largest producing coalfield in British Columbia. There are also non-point

source discharges from agriculture, urban development, forestry, transportation and stream bank erosion.

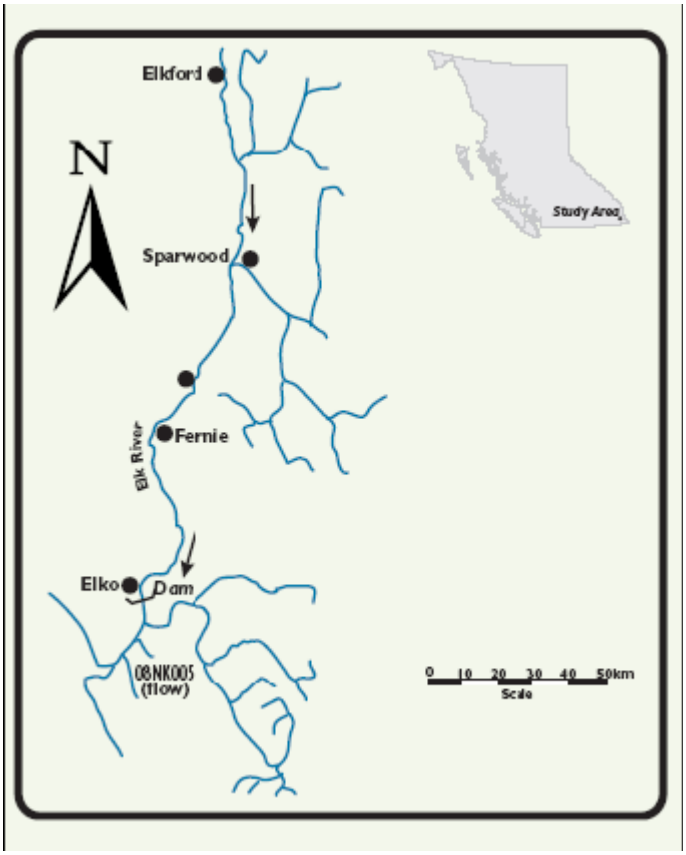

FIGURE 1: ELK RIVER NEAR SPARWOOD

WATER QUALITY ASSESSMENT

Data for the Elk River downstream form Sparwood 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 form 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. 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: total and dissolved antimony, boron, pH, dissolved ortho phosphorus, and total phosphorus.

The following water quality indicators that are not discussed further in the report seemed to fluctuate through the year according to turbidity concentrations, but were below guideline values (if guidelines exist) and had no other trends: arsenic (total), beryllium (total), bismuth (total), dissolved organic carbon, cobalt (total), copper (total), gallium

(total), lanthanum (total), lead (total), manganese (total), nickel (total), non-filterable residue, rubidium (total), thallium, tin, vanadium, and zinc.

Other water quality indicators that are not discussed further in the report seemed to fluctuate through the year according to the specific conductivity of the water. These types of indicators that were not measured above guideline values (if guidelines exist) included: barium, hardness, lithium, magnesium, molybdenum, nitrate plus nitrite nitrogen (dissolved), total dissolved nitrogen, strontium, sulphate, and uranium.

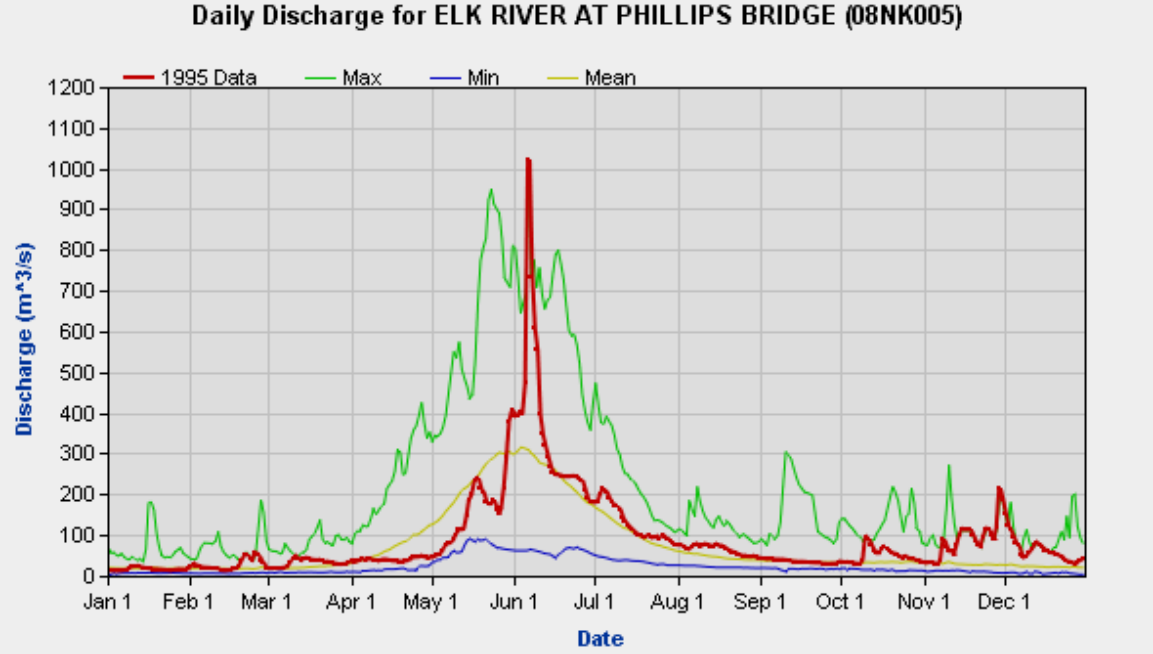

FIGURE 2: WATER SURVEY OF CANADA FLOW DATA FOR ELK RIVER AT PHILLIPS BRIDGE

Flow (Figure 2) values showed fairly typical patterns characteristic of interior river systems, with peak flows in May through June and low flows during August through March, generally declining through that period of time.

Aluminum (Figure 3) values (dissolved) never exceeded the guideline; however, total concentrations on occasion did exceed the dissolved aluminum guideline. These high total values corresponded to high turbidity values and so were not likely biologically available. As expected, there was no apparent correlation between dissolved aluminum and turbidity levels.

Cadmium (Figure 12) when measured as total concentrations at times exceeded the guideline that fluctuates with hardness. These high total values were correlated with higher turbidity values, meaning that the cadmium was likely in particulate form and not biologically available. All but one dissolved cadmium concentrations were always less than the guideline.

Calcium (Figure 13) values fluctuated with specific conductivity, as expected. Values were well in excess of 8 mg/L guideline that indicates that the water is well buffered to acidic inputs.

Chromium (Figure 15) concentrations (total) fluctuated with turbidity and occasionally exceeded the most restrictive guideline for hexavalent chromium. The chromium was likely associated with particulate matter on such occasions and would not be biologically available. All dissolved concentrations were below the hexavalent chromium guideline.

Fecal Coliforms (Figure 17) occasionally exceeded the guideline for source water protection where only disinfection is used, but these higher values were associated with increased turbidity values. Partial treatment of the source water would be needed for effective disinfection to take place during those periods.

True Colour (Figure 18) values were usually below the guideline with only one value exceeding the guideline. There was no apparent correlation between colour and turbidity.

Escherichia Coli (Figure 20) values often exceeded the B.C. guideline of 10 CFU/1000 mL to protect water supplies with only disinfection.

Fluoride (Figure 21) may be showing a slight trend to decreasing concentrations; however, the period of record (four years) is too short to confirm this.

Iron (Figure 25) concentrations (total) occasionally exceeded the guidelines for the protection of aquatic life and aesthetics of source water supplies used for drinking. Total iron concentrations were correlated with turbidity meaning that the iron was likely in particulate form and not biologically available. All dissolved values were less than the guidelines.

Selenium (Figure 43) values seemed to fluctuate with conductivity. The high selenium may be associated with runoff form the open pit mining operations. All dissolved and total selenium values exceeded the B.C. 30-day mean and the CCME maximum guideline values. There is no apparent trend of increasing concentrations through time although this may be related to the short period of record (four years).

Sliver (Figure 44) values in 2002 exceeded the guideline but this appears to be purely a function of the detection limit because when it was reduced in 2003, all values met the guideline to protect aquatic life. Any total silver values that are above the detection limit since that time are correlated to higher turbidity values, meaning that the silver is in particulate form ad not likely biologically available.

Temperature (Figure 48) values in water peaked above the guideline for the maximum incubation temperature in the spring or autumn; however, the high values were always recorded during the summer so there would be no concerns for temperature.

Turbidity (Figure 51) has occasionally been above the guideline for source waters used for drinking with no treatment. Therefore some treatment will be required for solids removal on occasion..

REFERENCES

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

Ministry of Environment. 2006b. A Compendium of Working Water Quality Guidelines for British Columbia. Ministry of Environment, Victoria, B.C.

Figure 3
Elk River below Sparwood
Aluminum Total and Dissolved (ug/L)
2002 - 2005

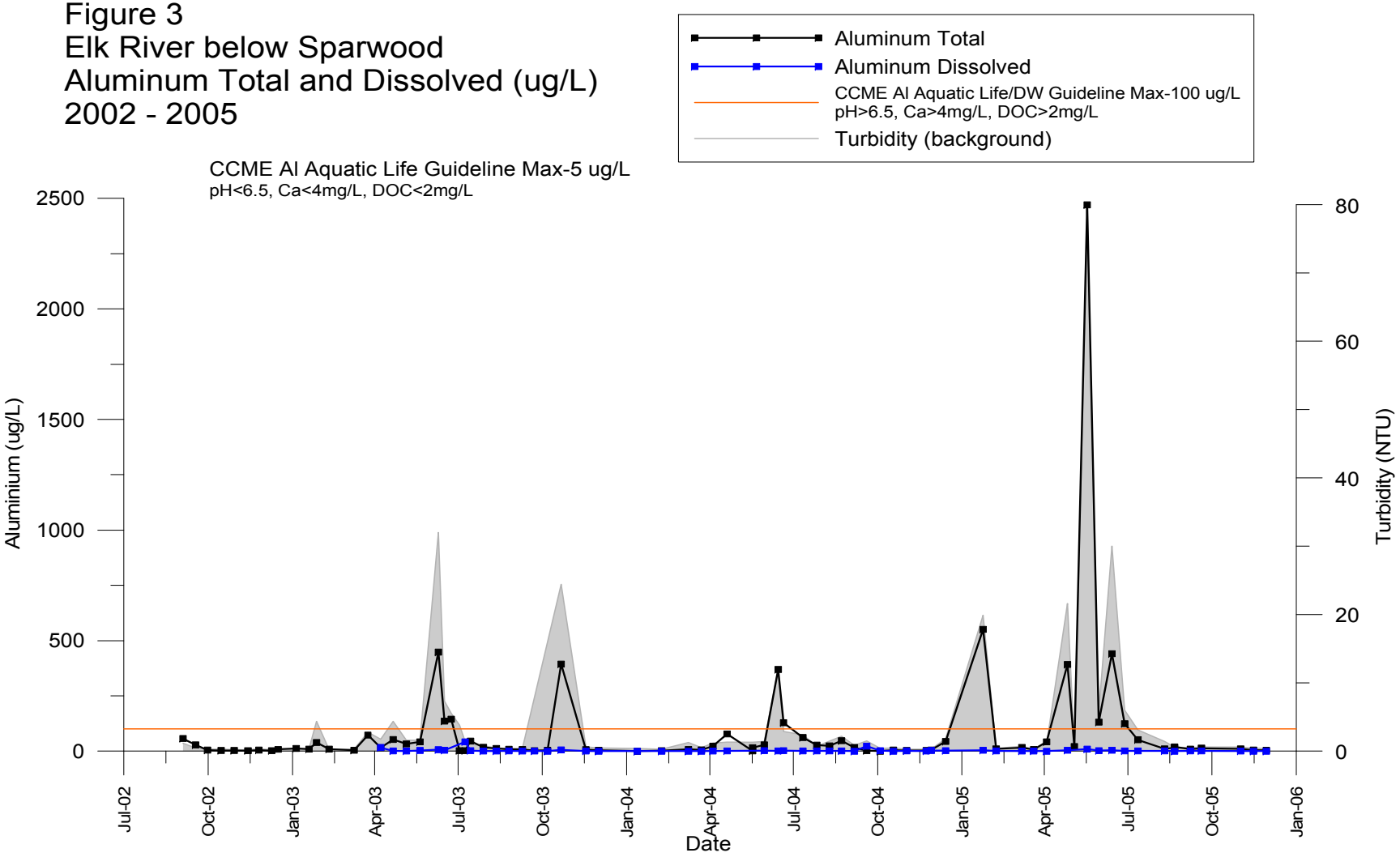

Figure 4
Elk River below Sparwood
Aluminum Dissolved (ug/L)
2003 - 2005

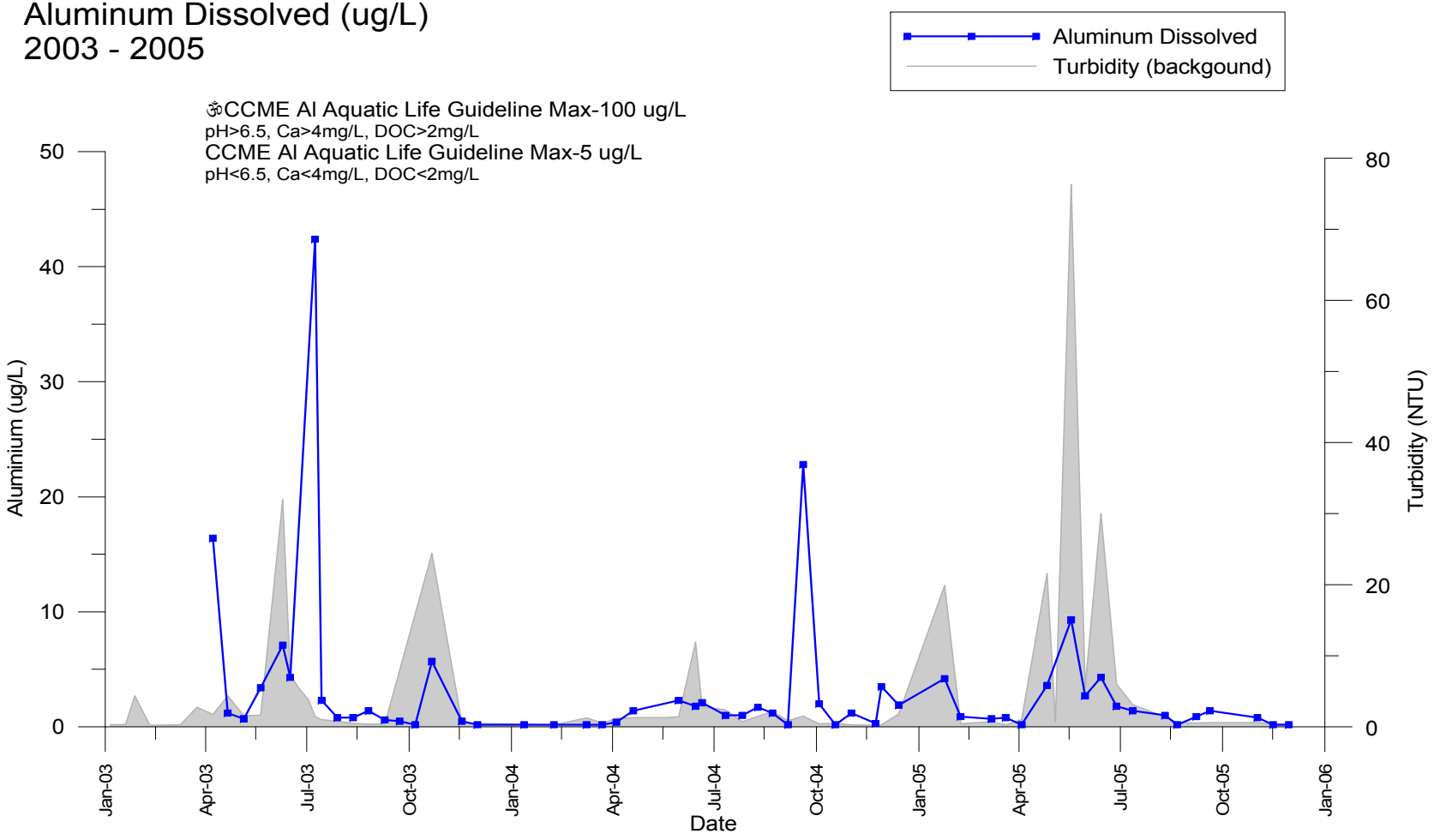

Figure 5
Elk River below Sparwood
Antimony Total and Dissolved (ug/L)

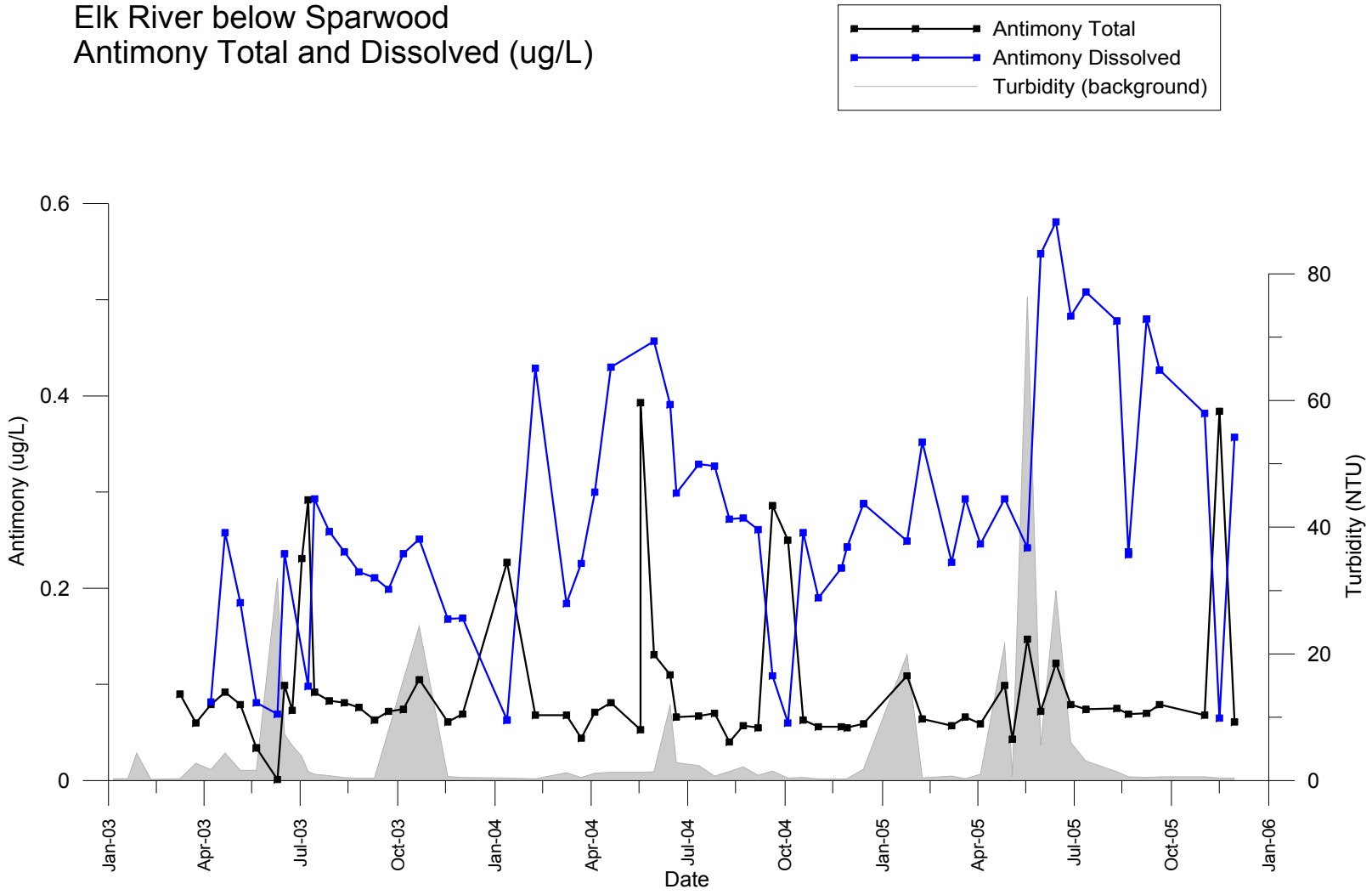

Figure 6
Elk River below Sparwood
Arsenic Total and Dissolved (ug/L)

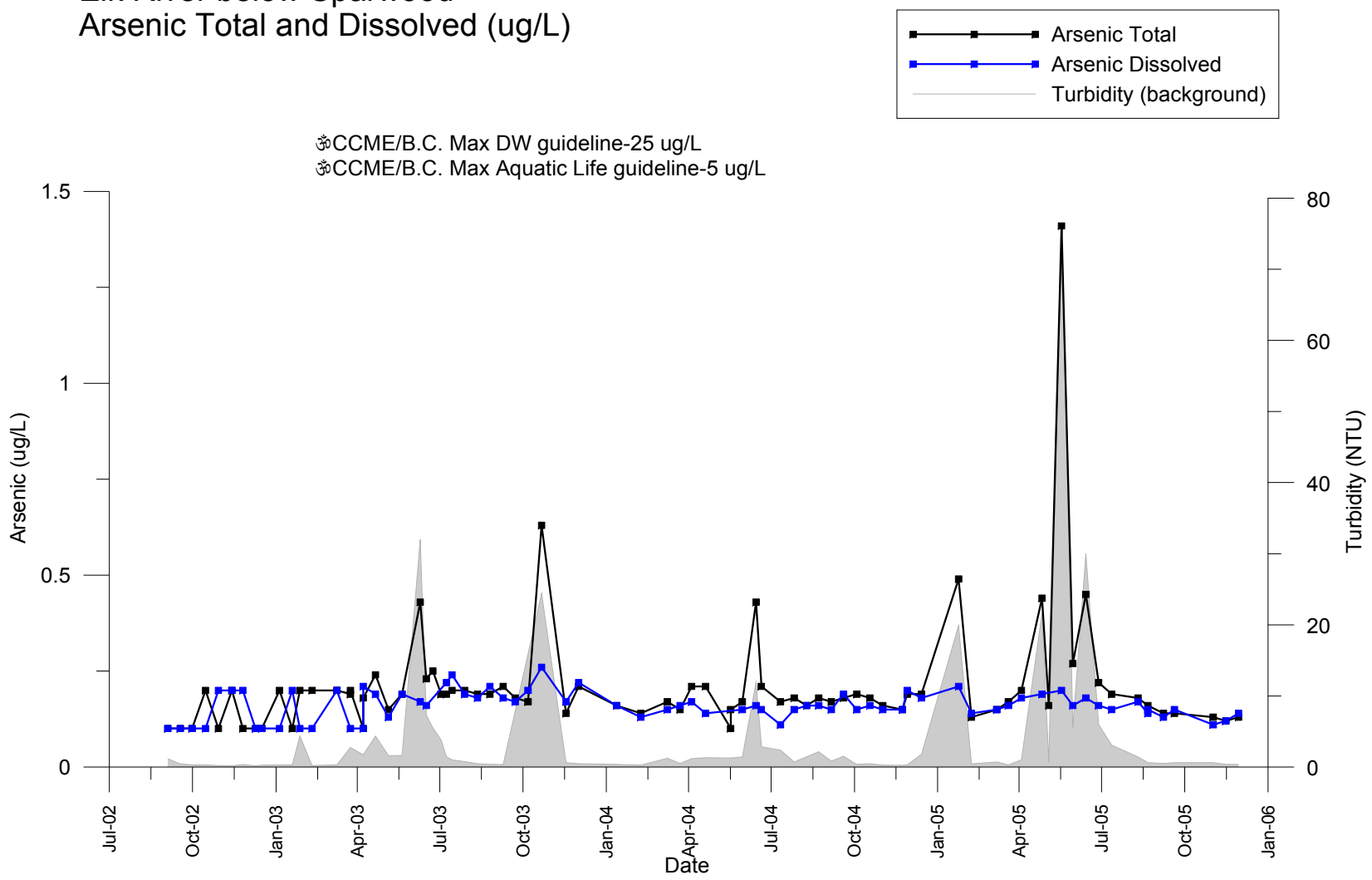

Figure 7
Elk River below Sparwood
Barium Total and Dissolved (ug/L)

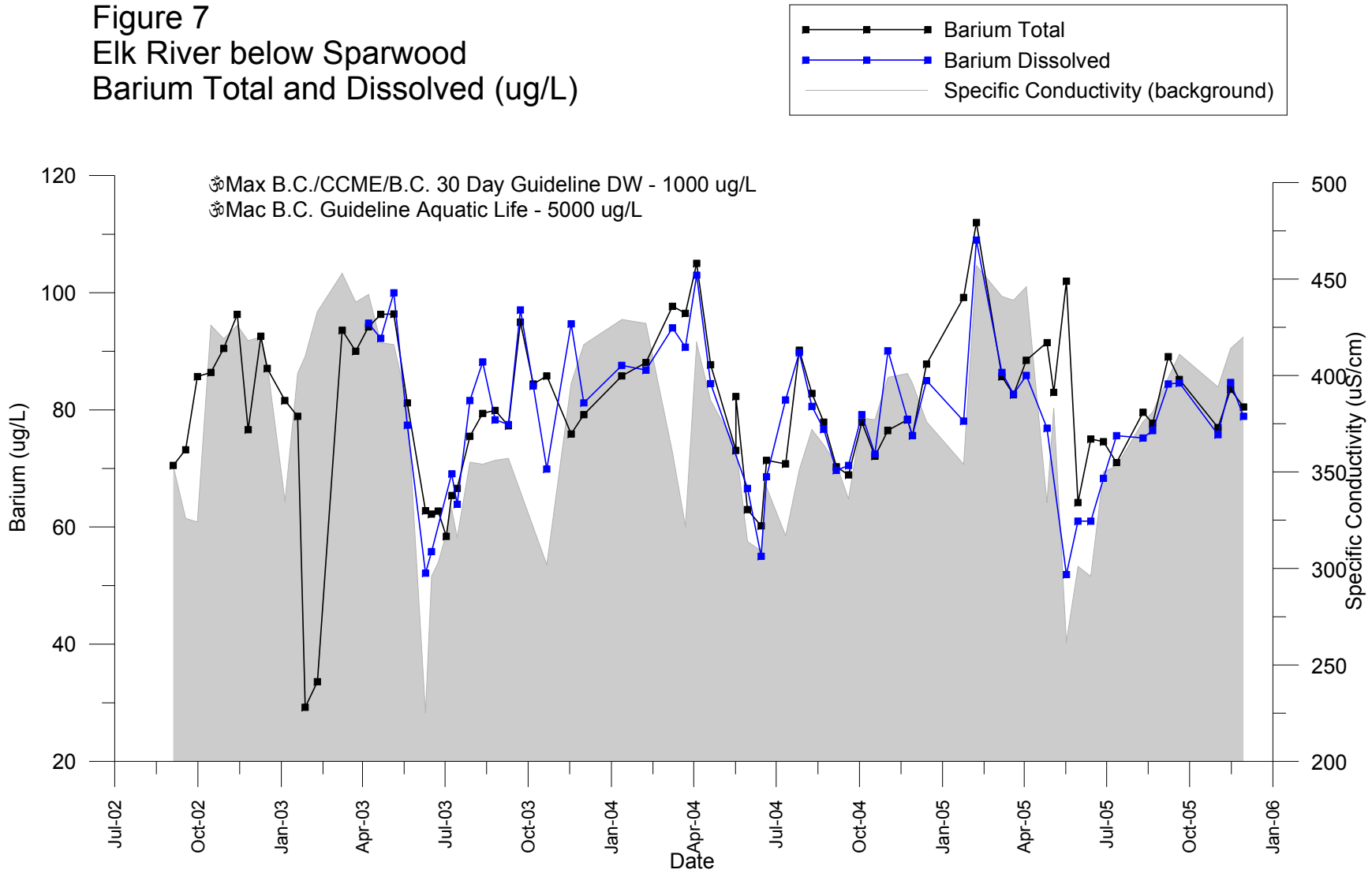

Figure 8
Elk River below Sparwood
Beryllium Total and Dissolved (ug/L)
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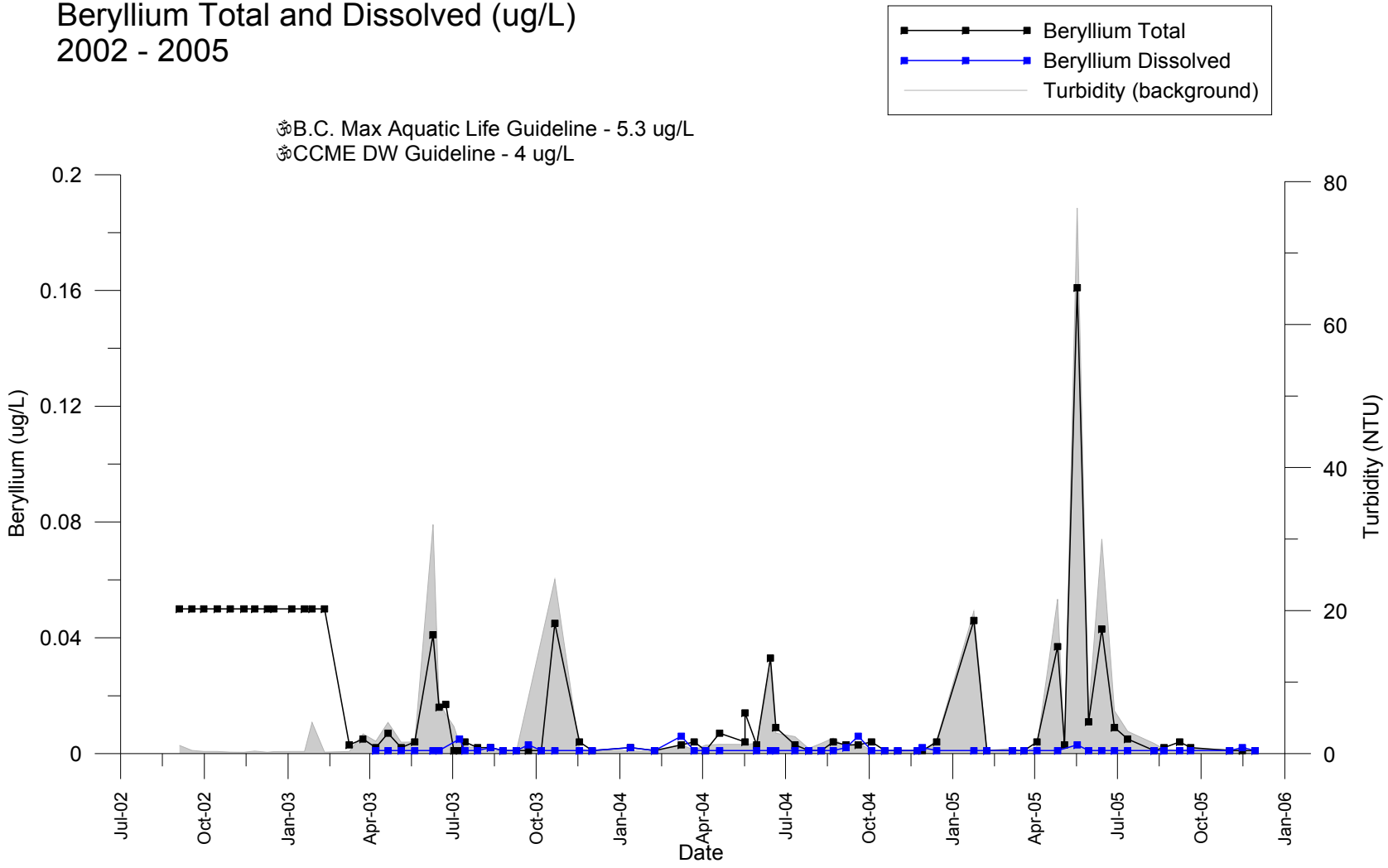

Figure 9
Elk River below Sparwood
Beryllium Dissolved (ug/L)
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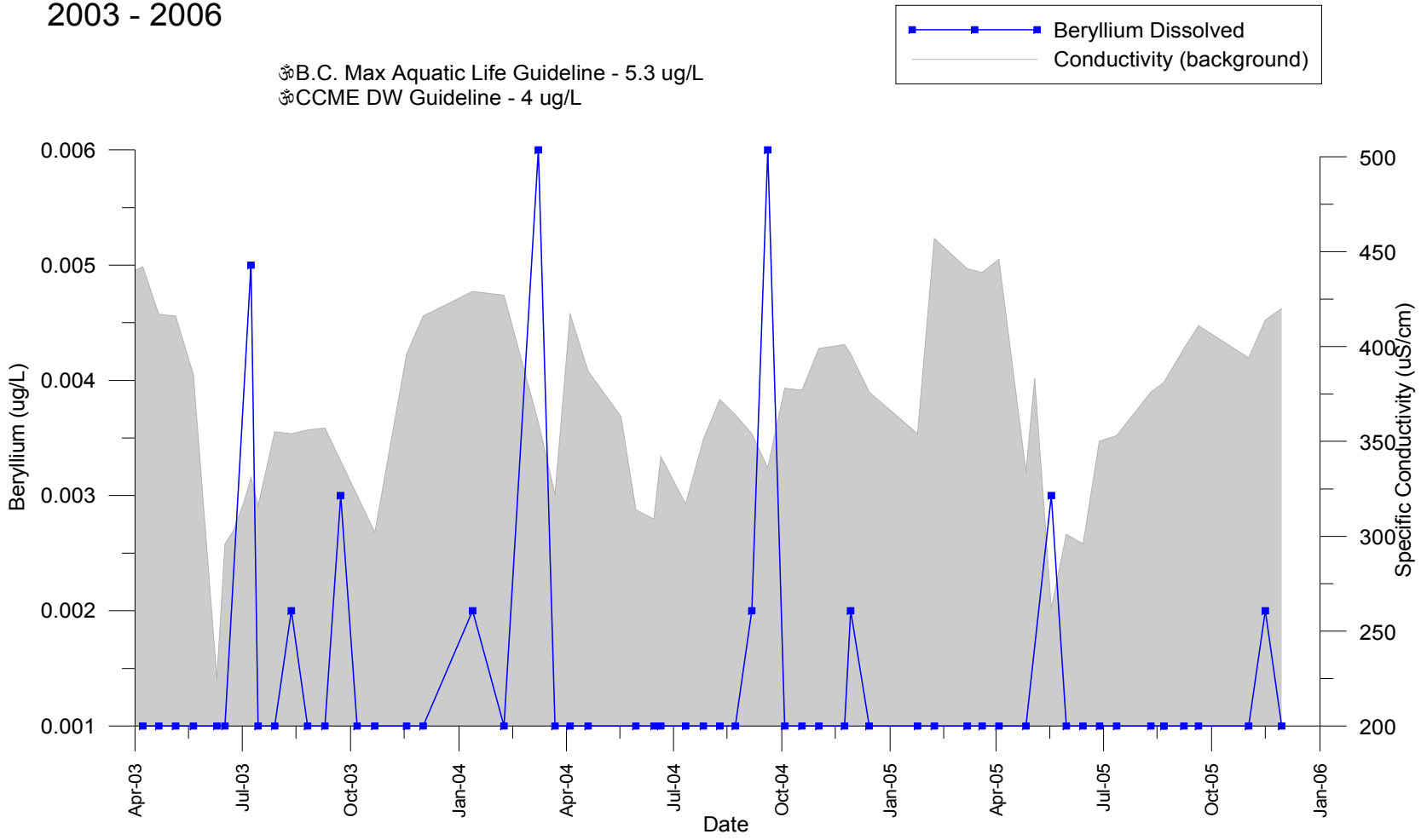

Figure 10
Elk River below Sparwood
Bismuth Total and Dissolved (ug/L)

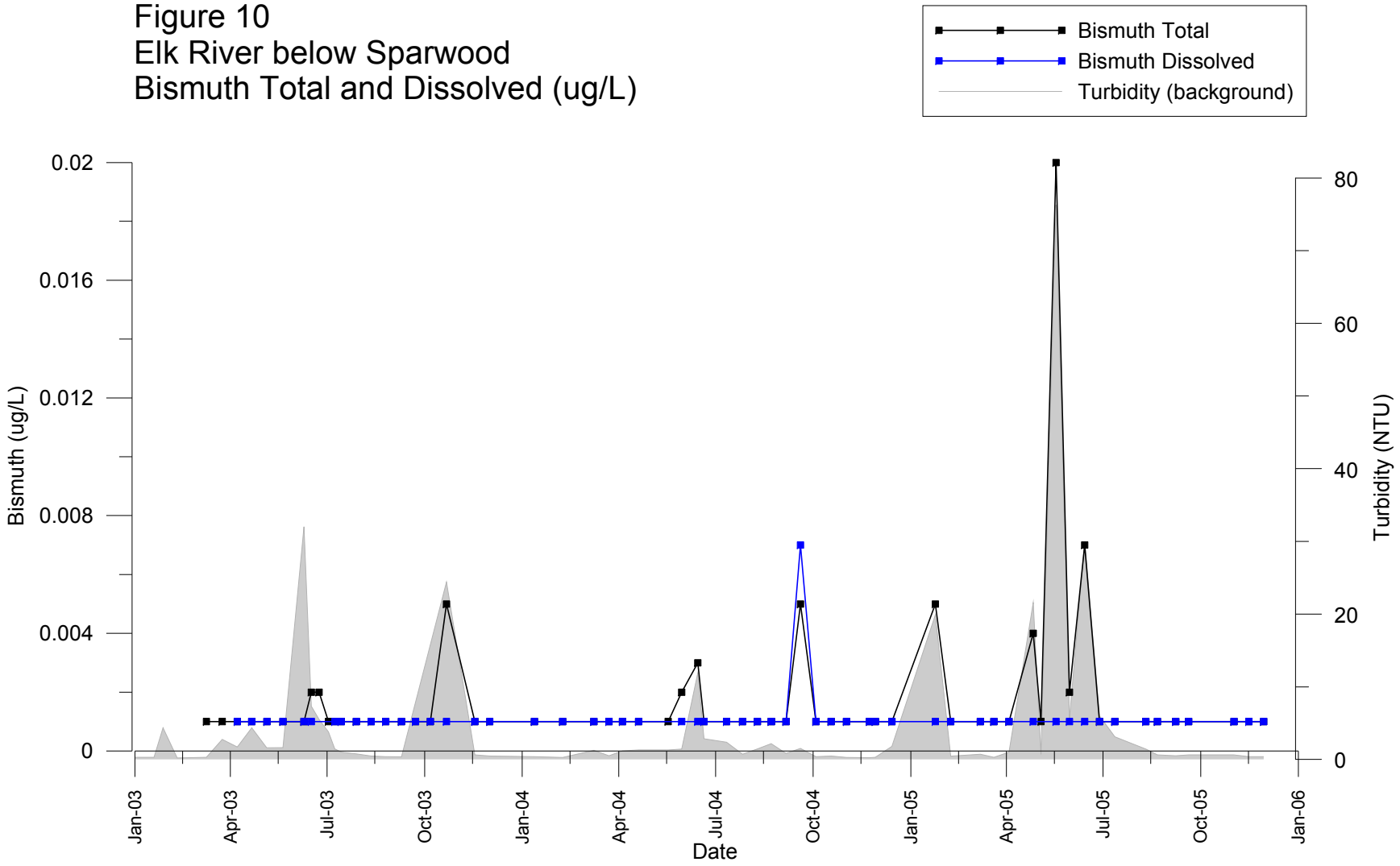

Figure 11
Elk River below Sparwood
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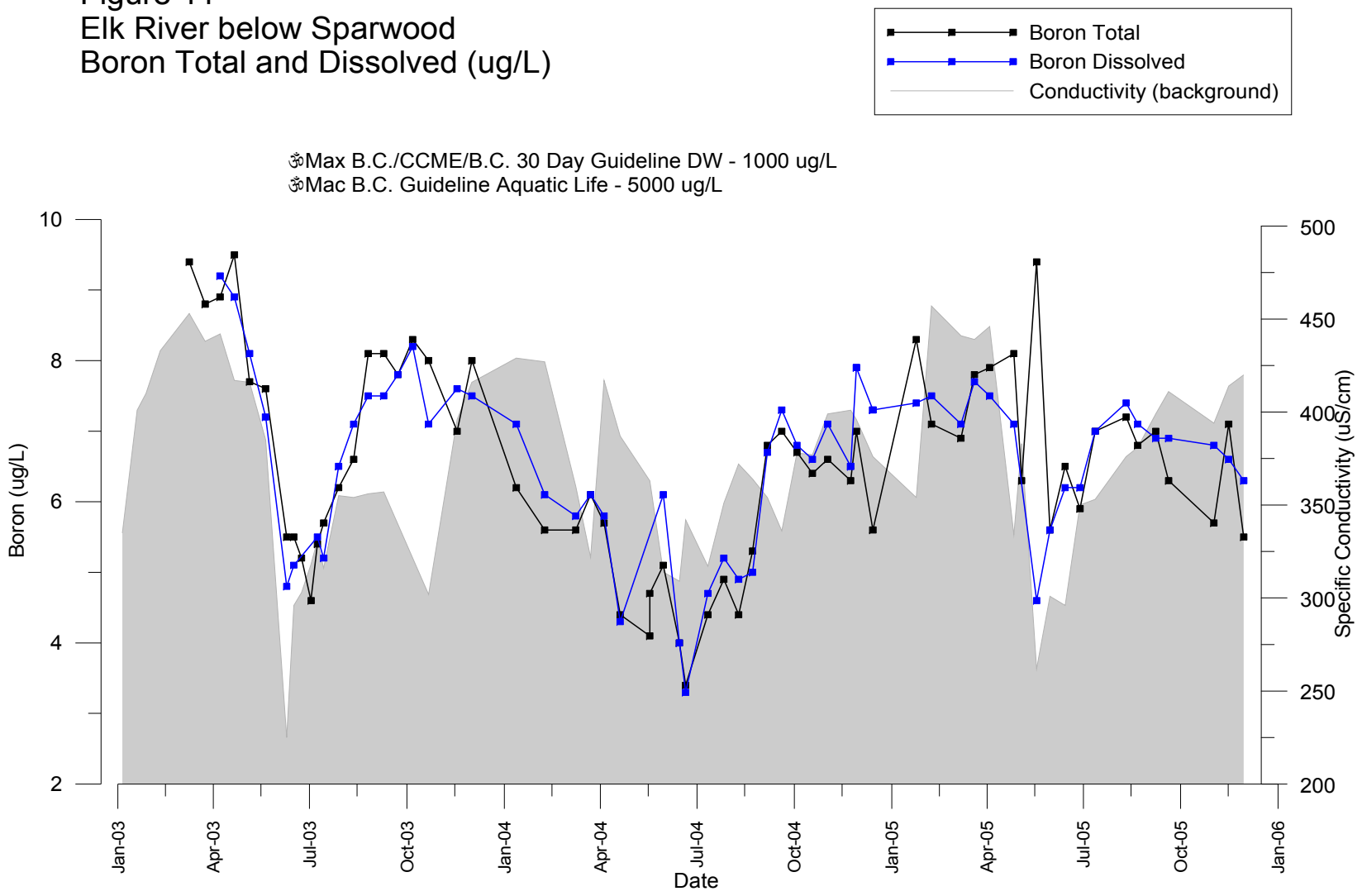


Figure 12
Elk River below Sparwood
Cadmium Total and Dissolved ug/L)

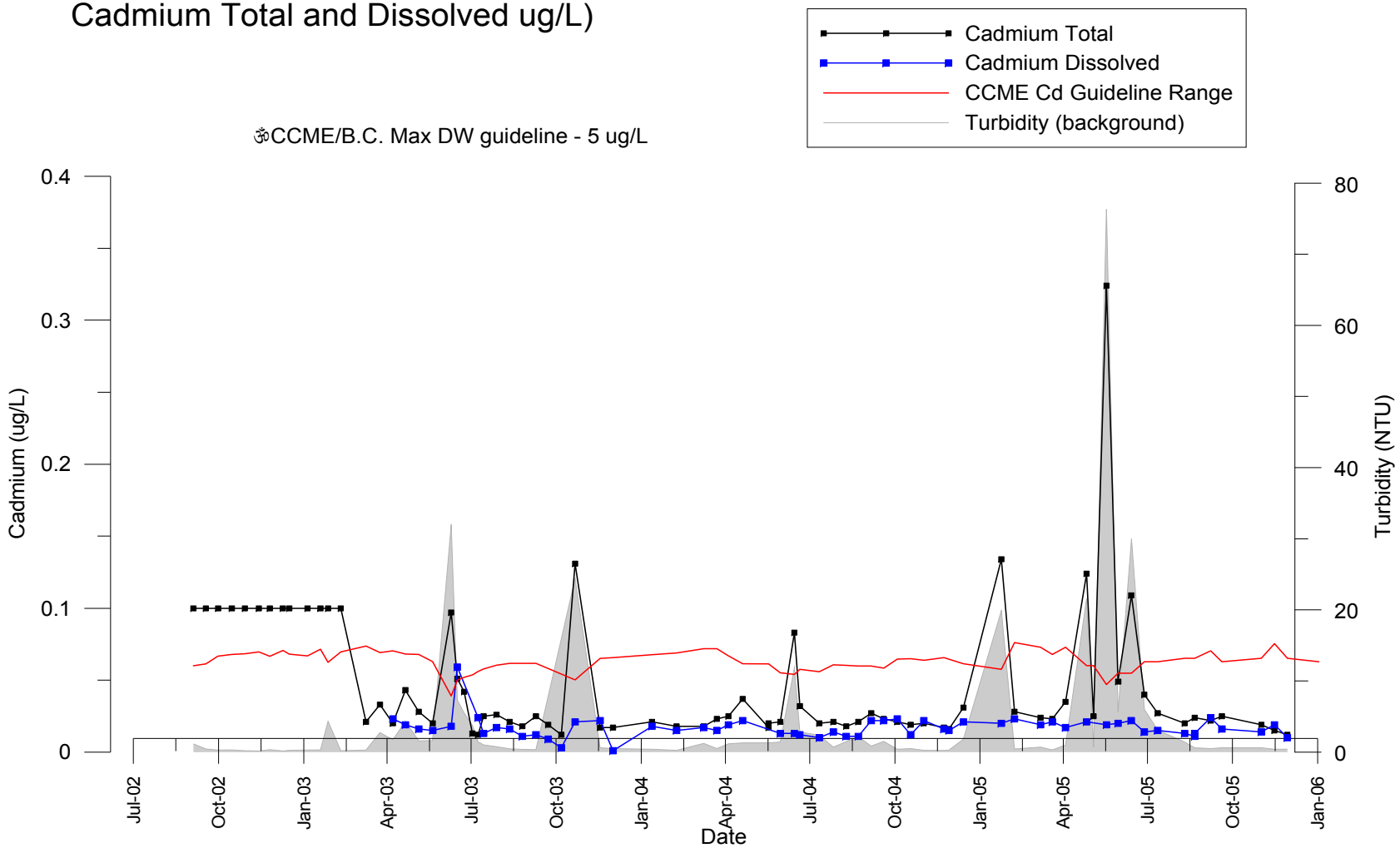
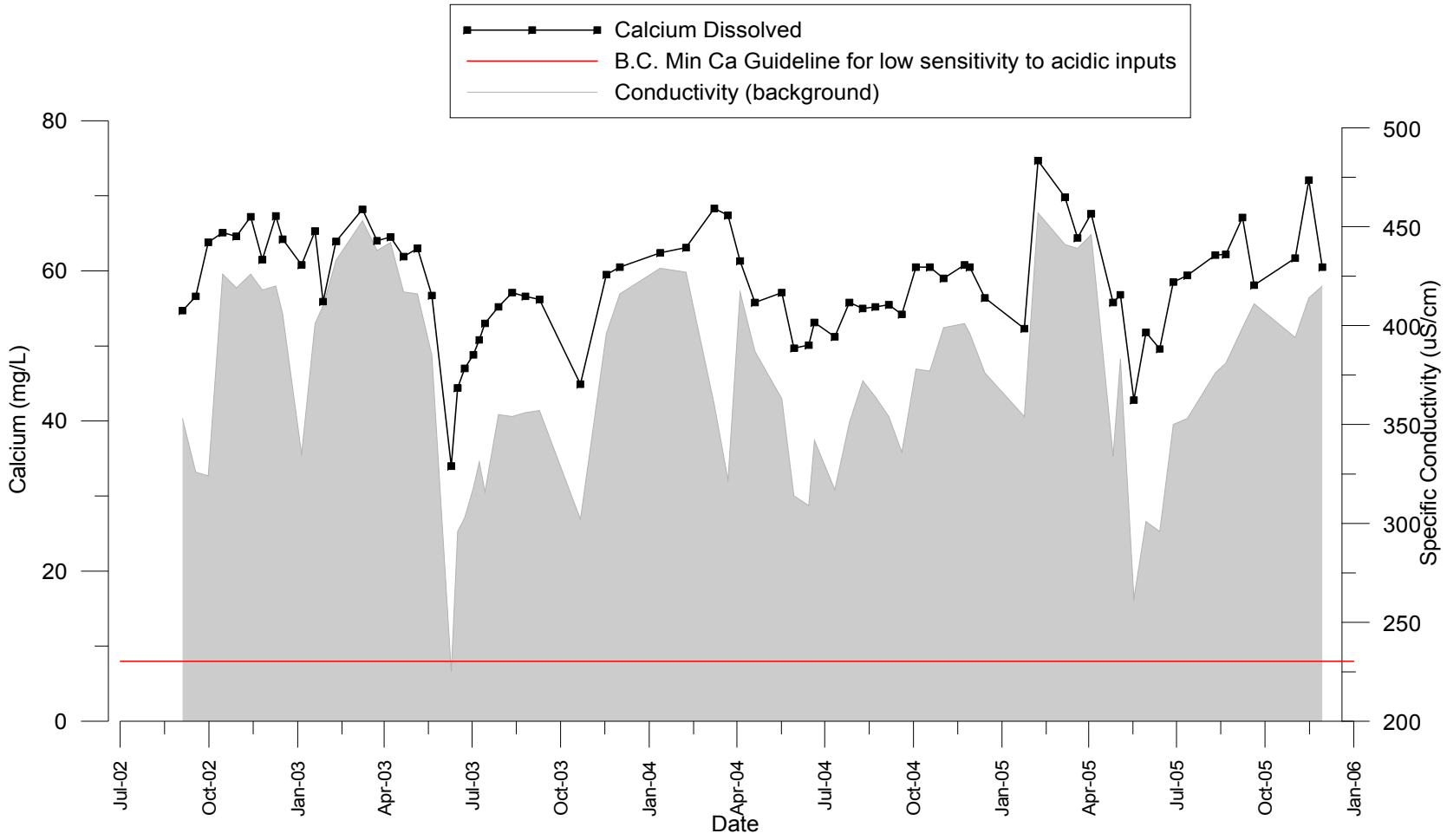


Figure 13
Elk River below Sparwood
Calcium Dissolved (mg/L)



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Elk River below Sparwood
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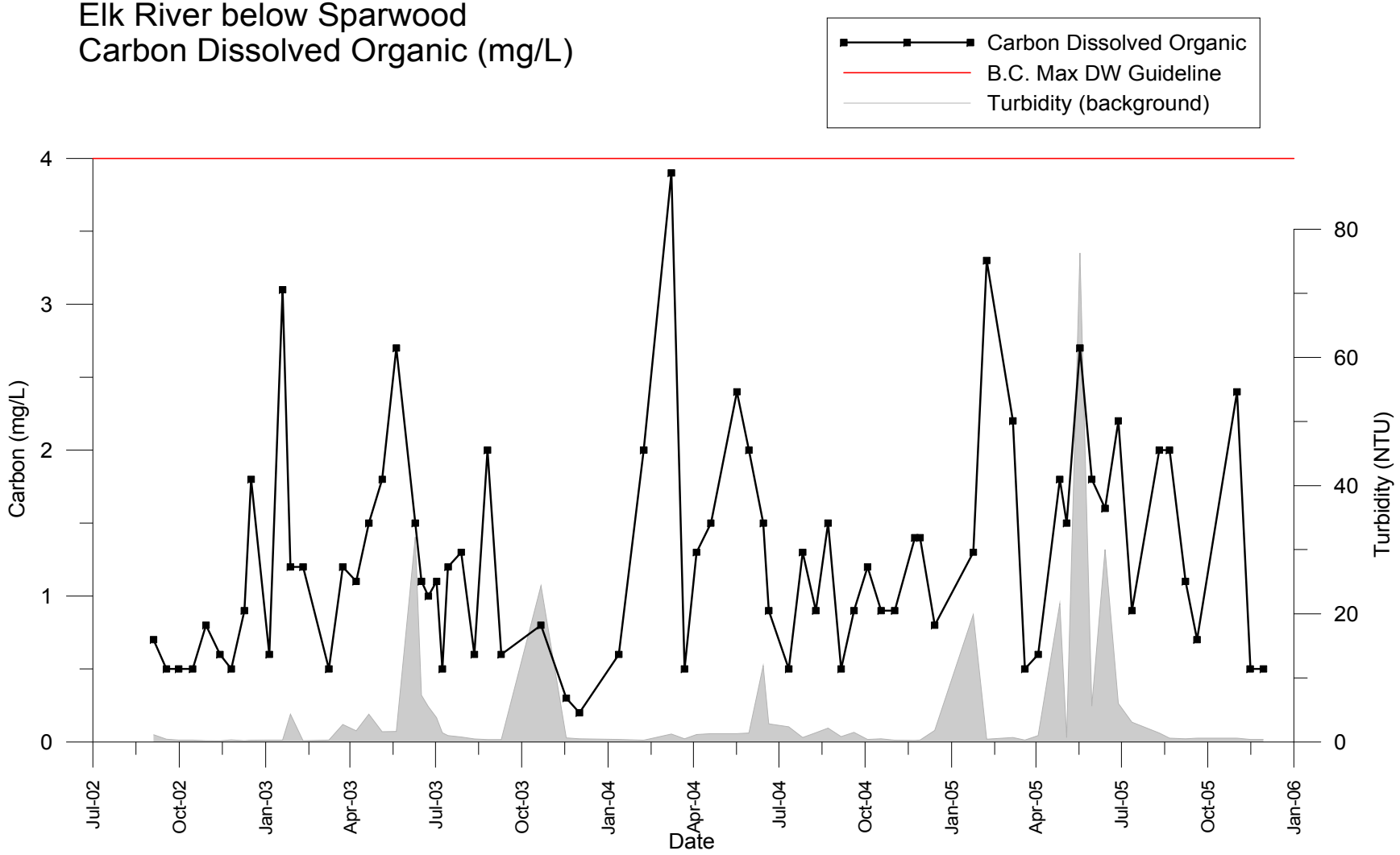

Figure 15
Elk River below Sparwood
Chromium Total and Dissolved (ug/L)

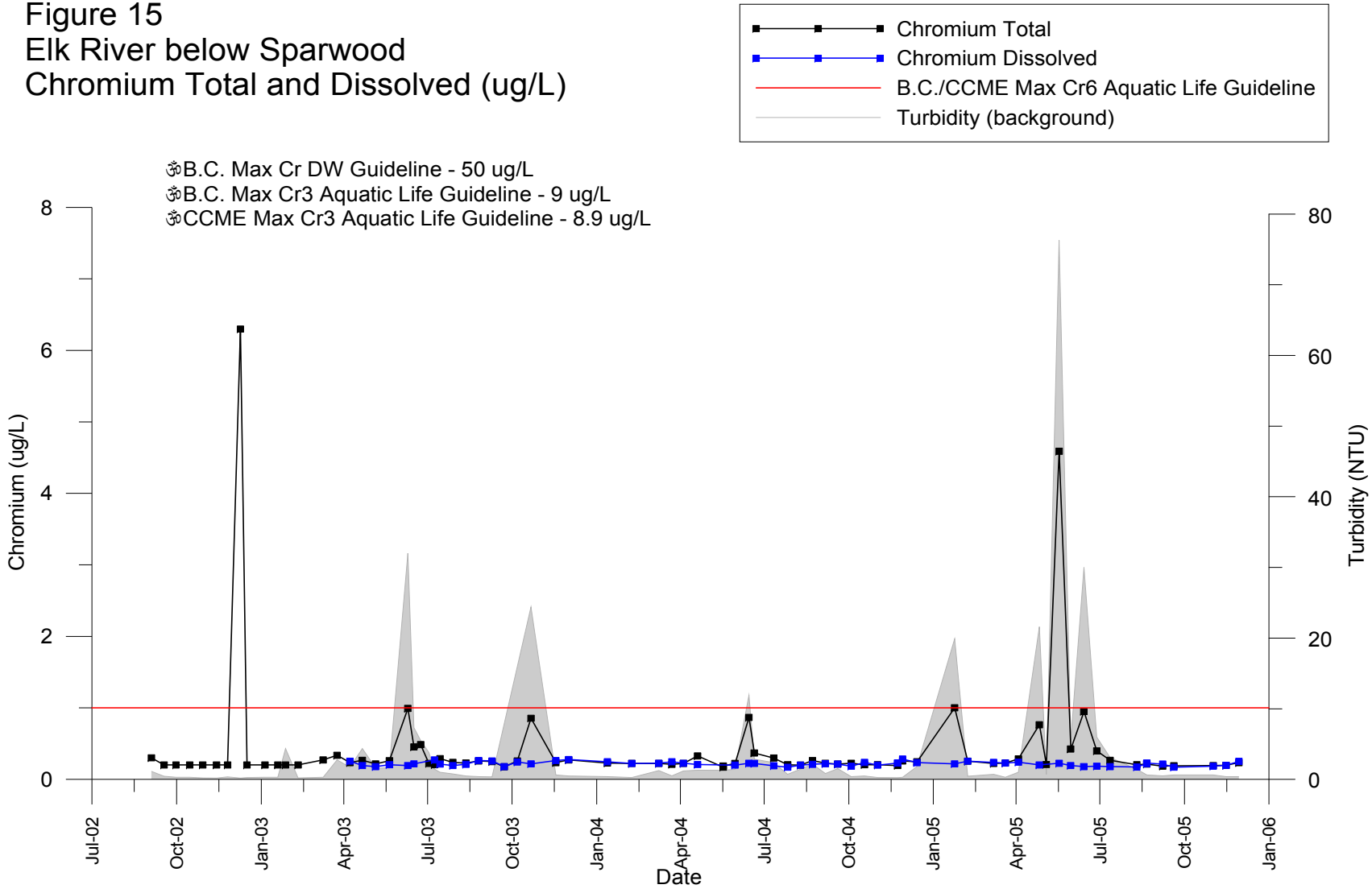

Figure 16
Elk River below Sparwood
Cobalt Total and Dissolved (ug/L)

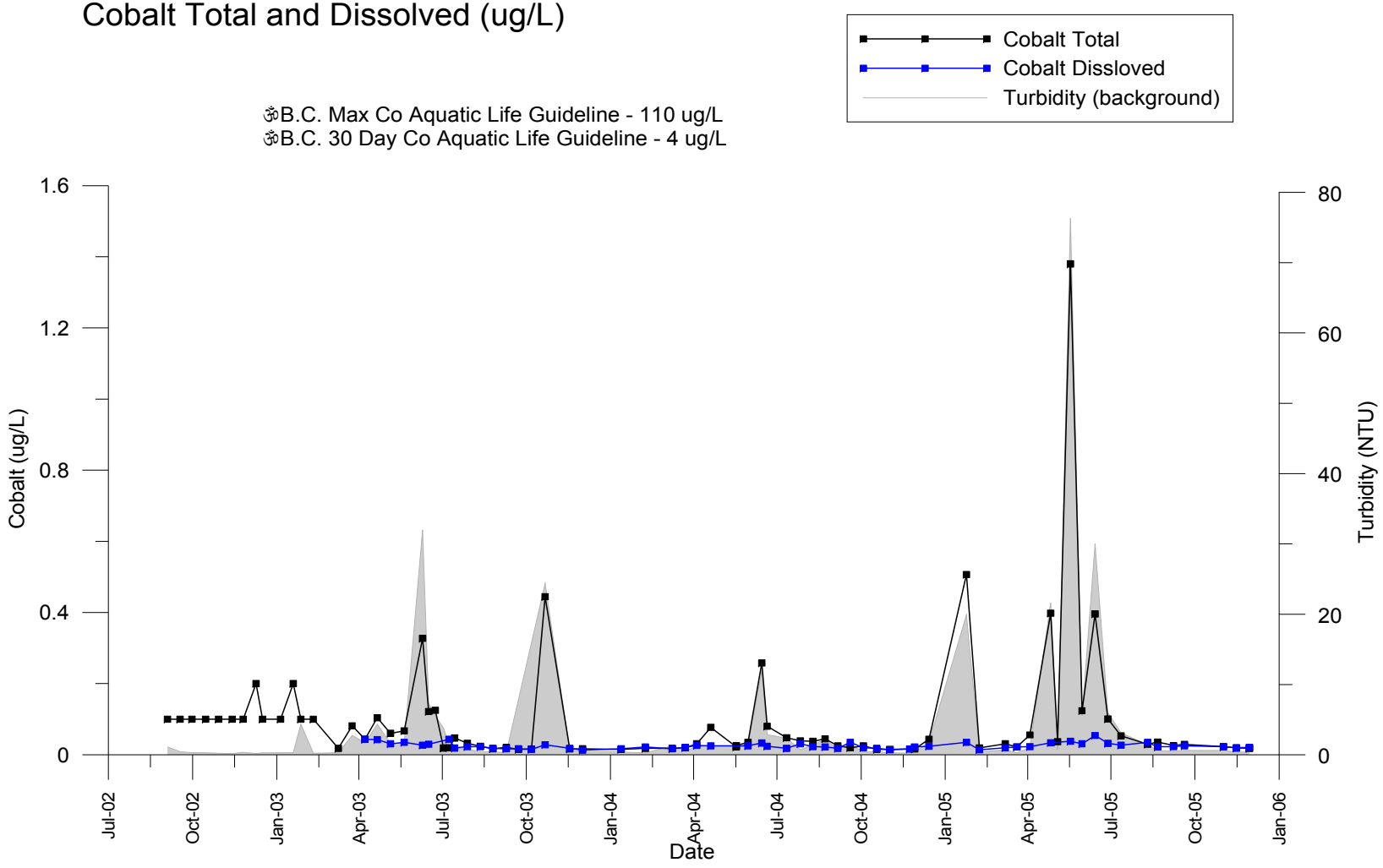

Figure 17
Elk River below Sparwood
Fecal Coliforms (CFU/100mL)

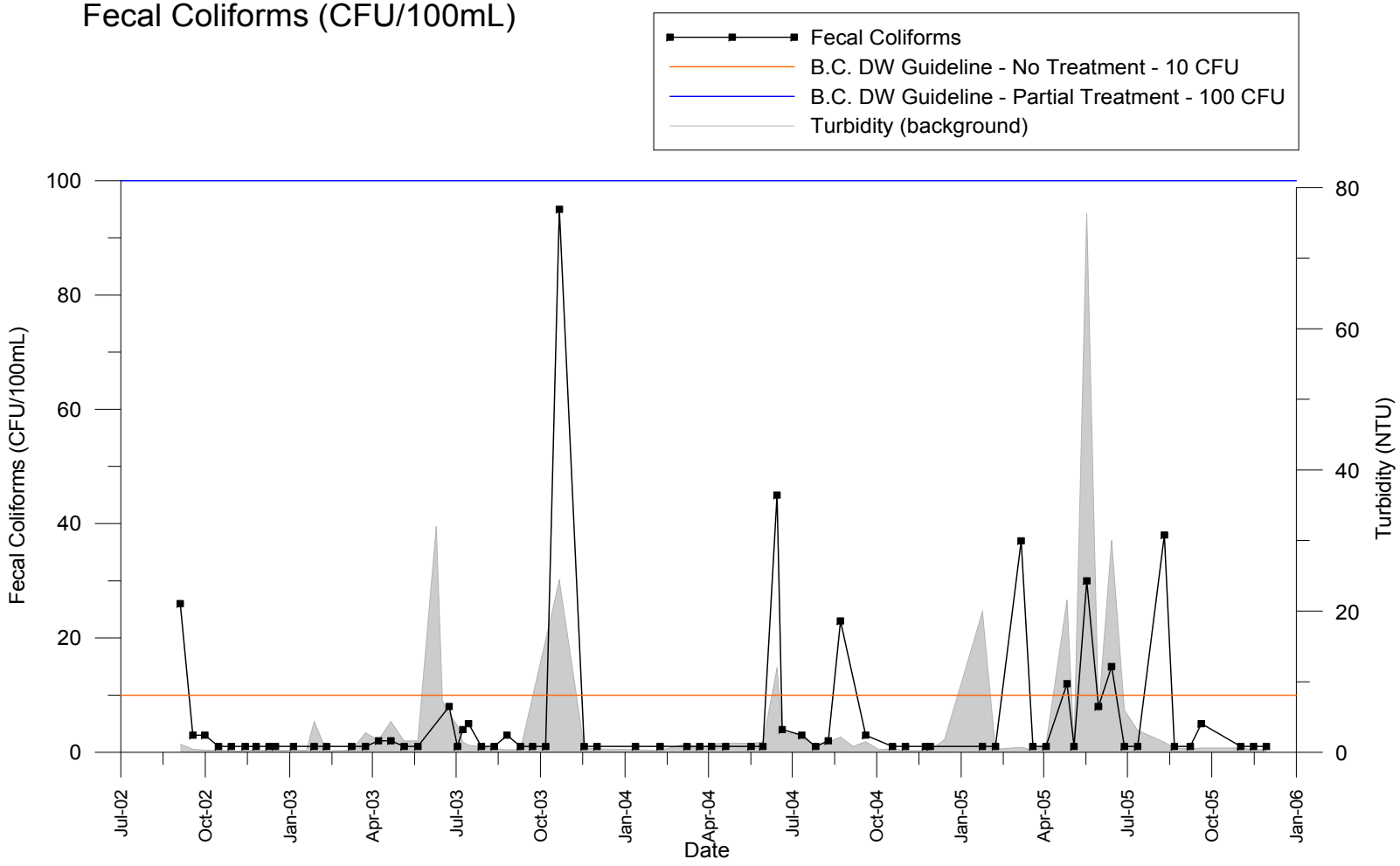

Figure 18
Elk River below Sparwood
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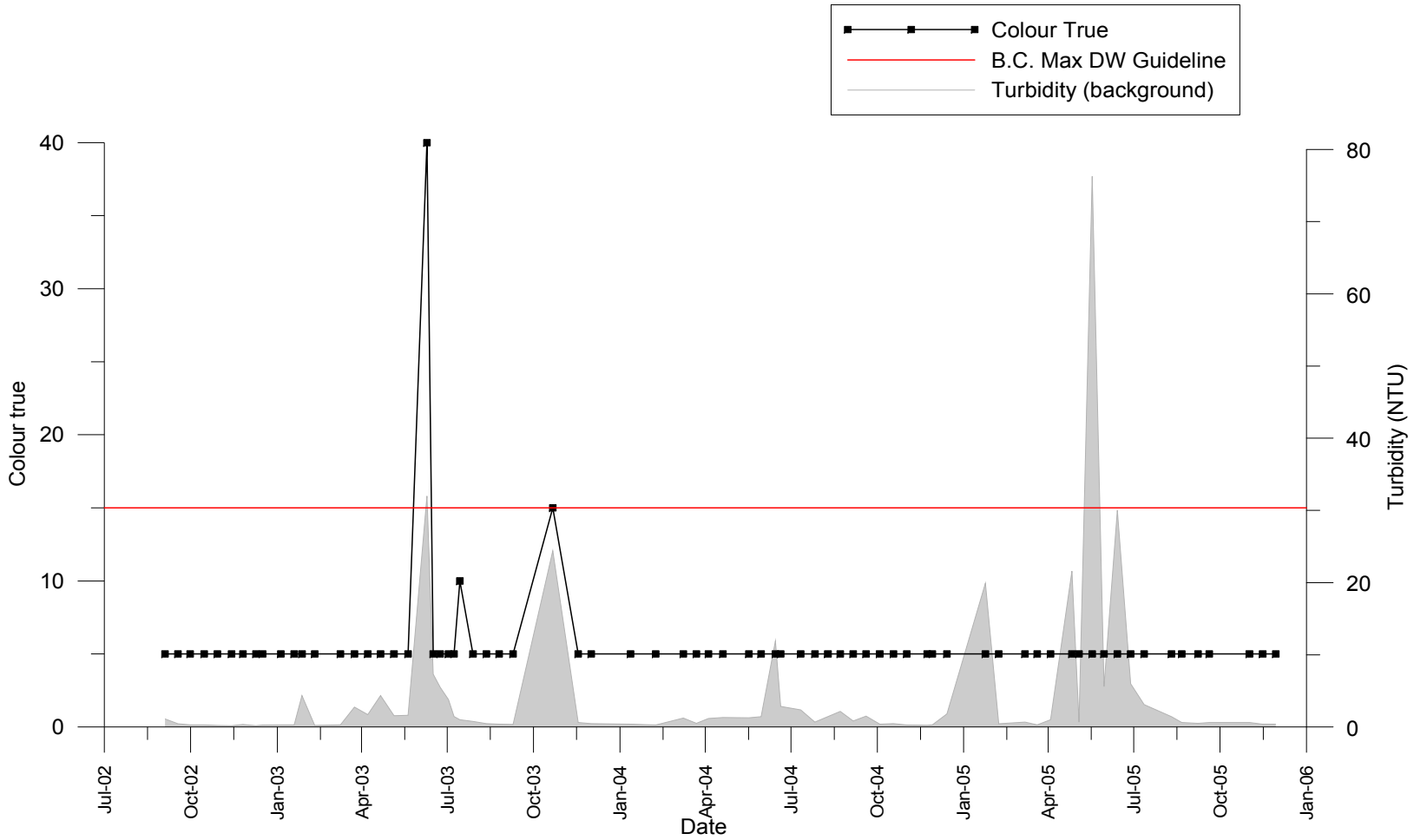

Figure 19
Elk River below Sparwood
Copper Total and Dissolved (ug/L)

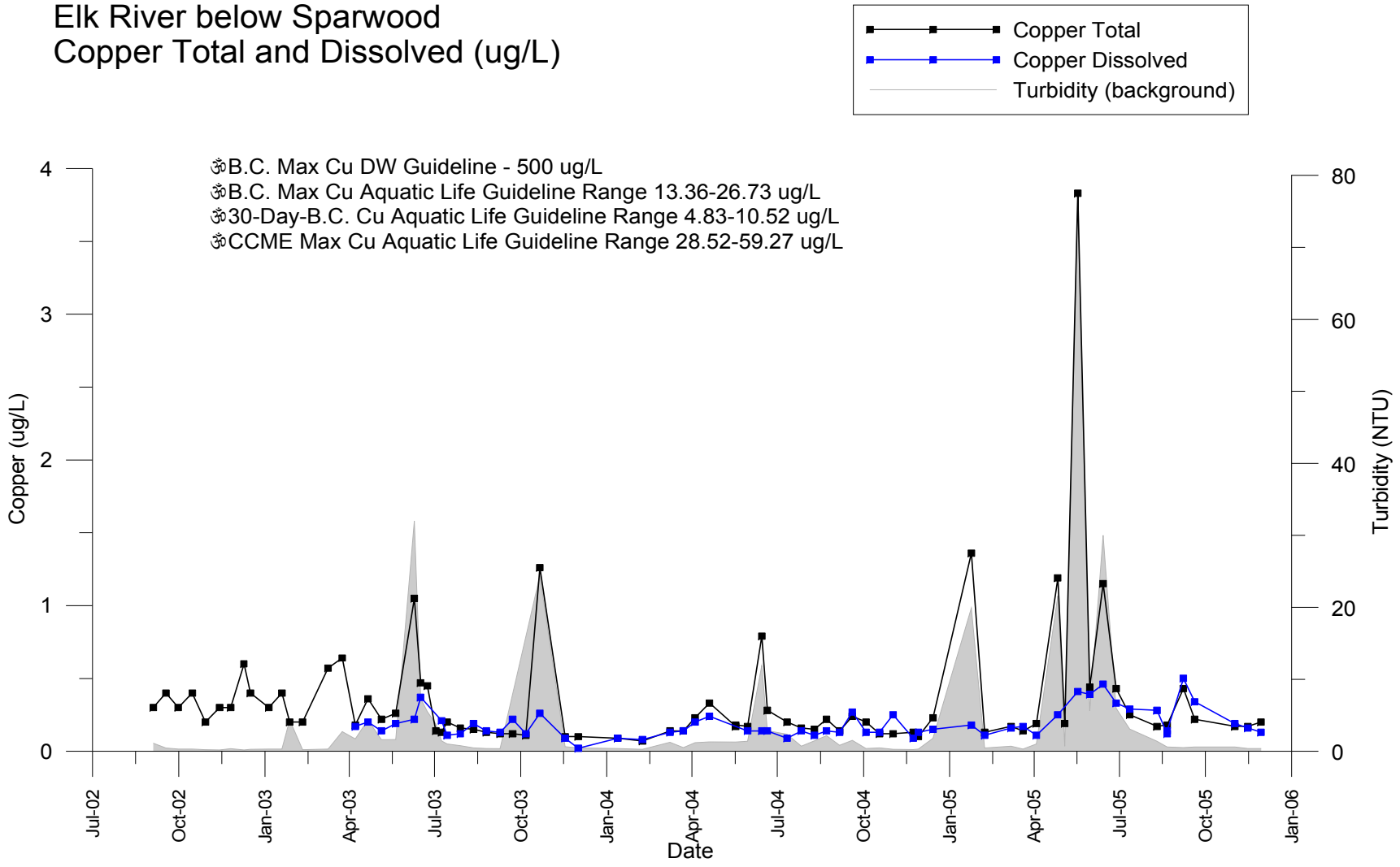

Figure 20
Elk River below Sparwood
Escherichia Coli (CFU/100mL)

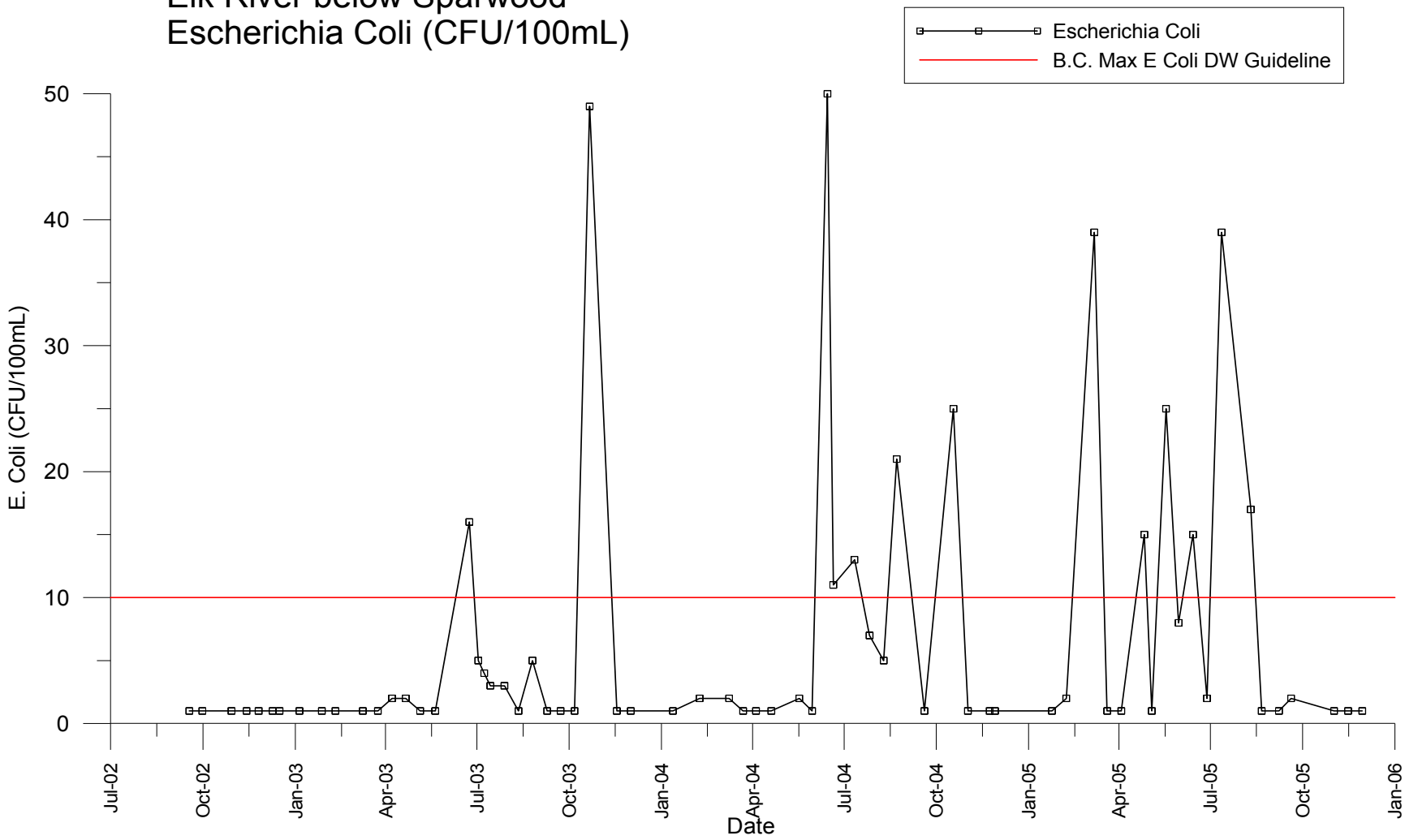

Figure 21
Elk River below Sparwood
Fluoride Total (mg/L)

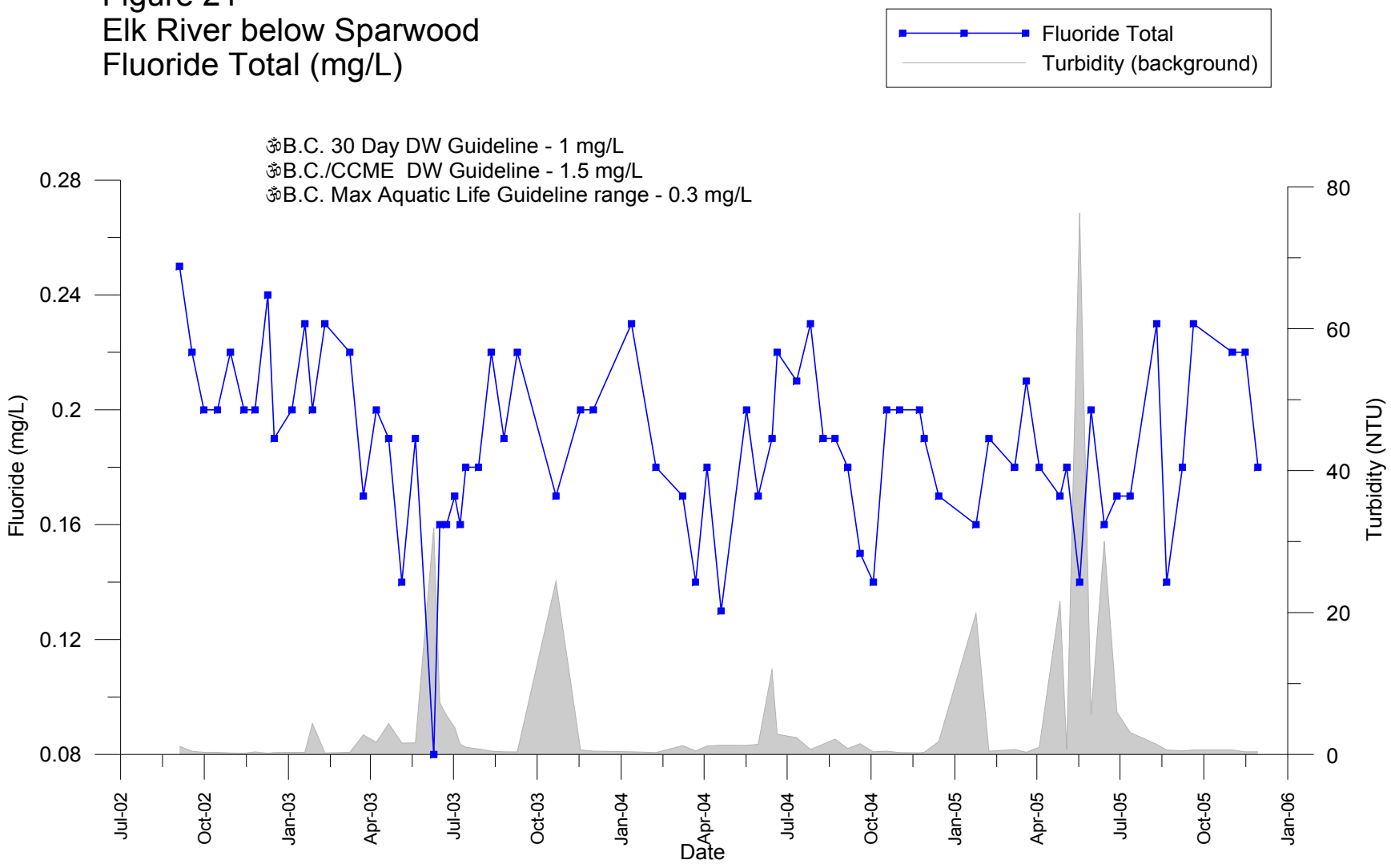

Figure 22
Elk River below Sparwood
Gallium Total and Dissolved (ug/L)
2003 - 2006

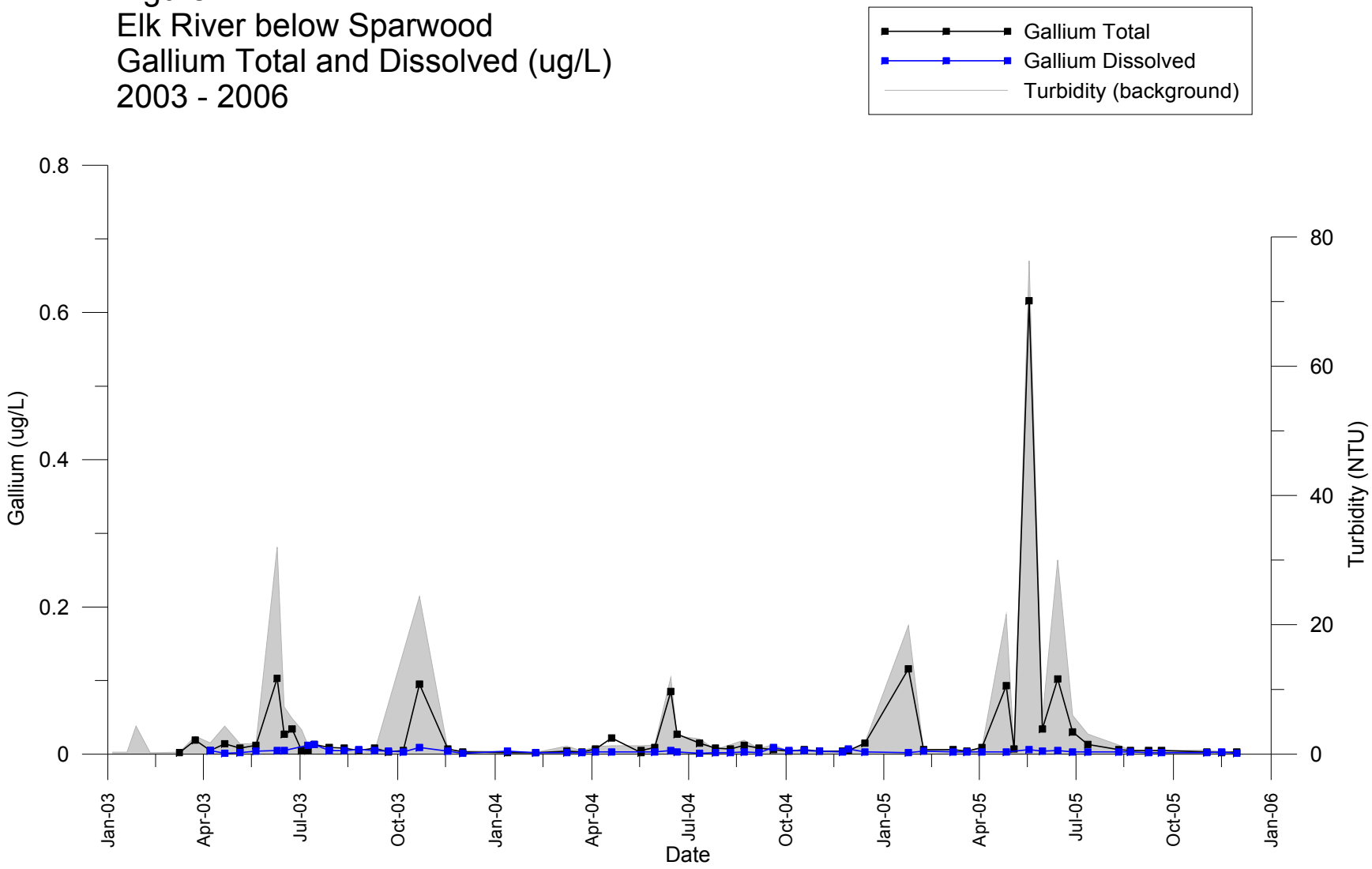

Figure 23
Elk River below Sparwood
Gallium Dissolved (ug/L)
2003 - 2006

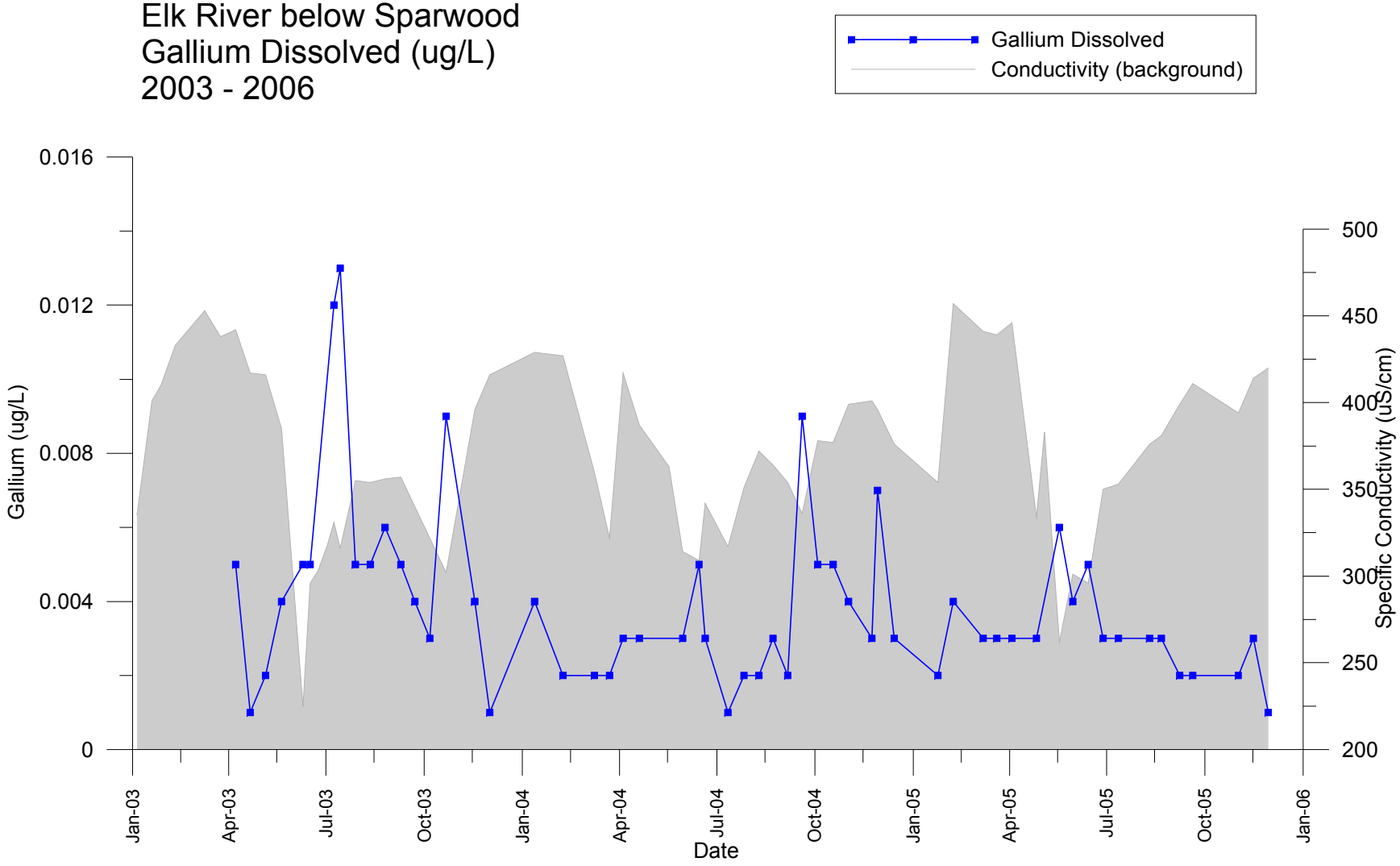

Figure 24
Elk River below Sparwood
Hardness Total Calcd (CaCO3)

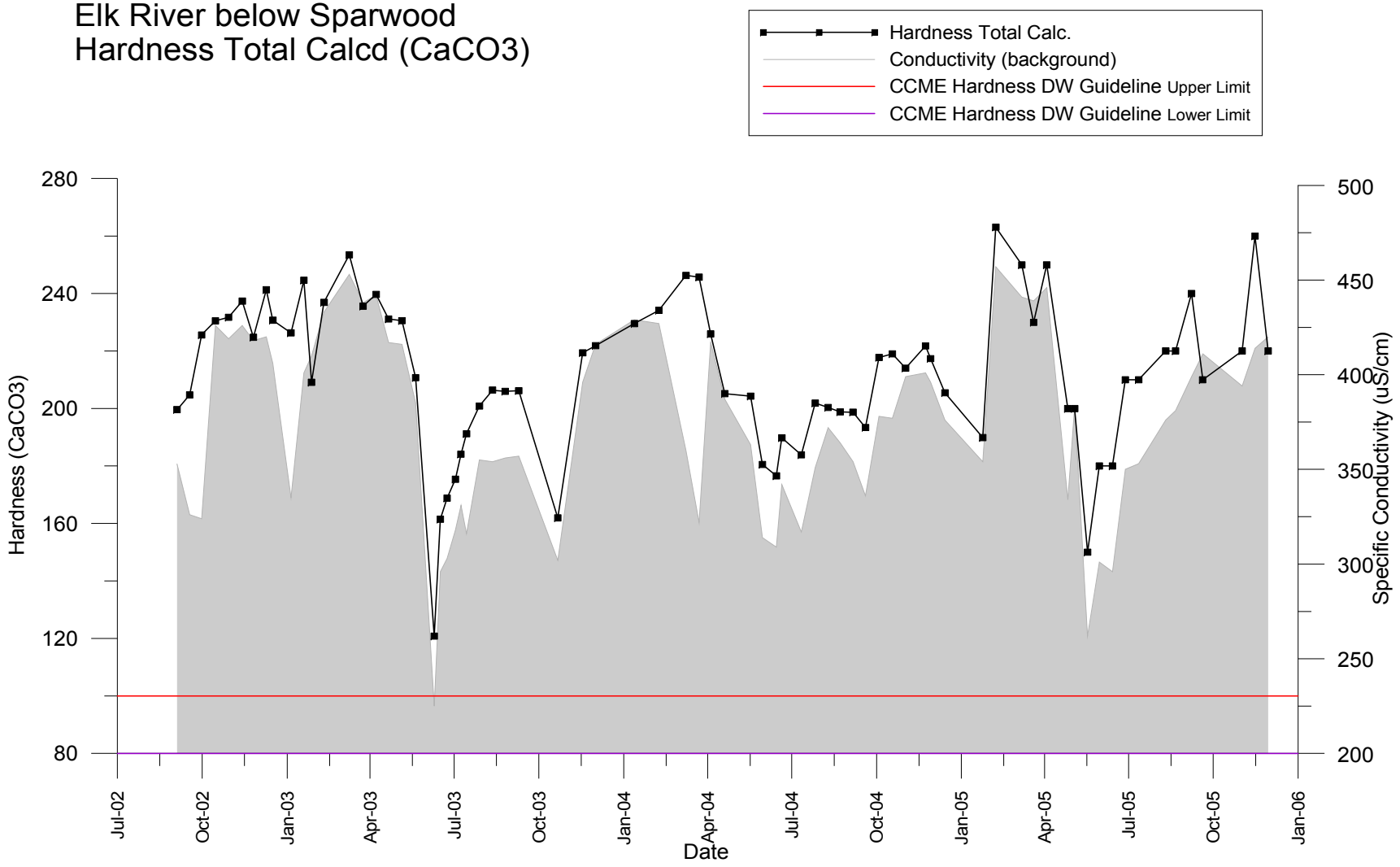

Figure 25
Elk River below Sparwood
Iron Total and Dissolved (ug/L)
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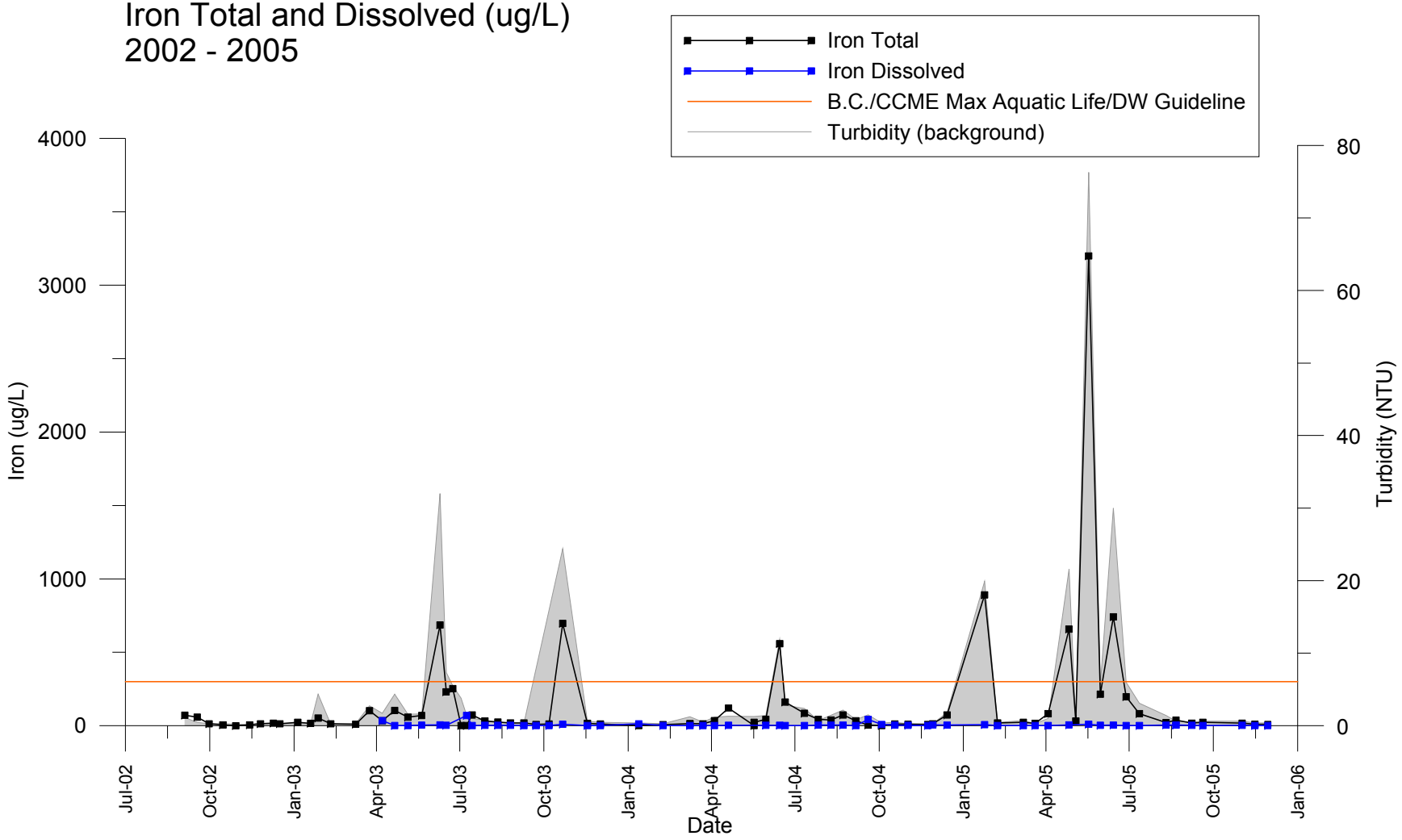

Figure 26
Elk River below Sparwood
Iron Dissolved (ug/L)
2003 - 2005

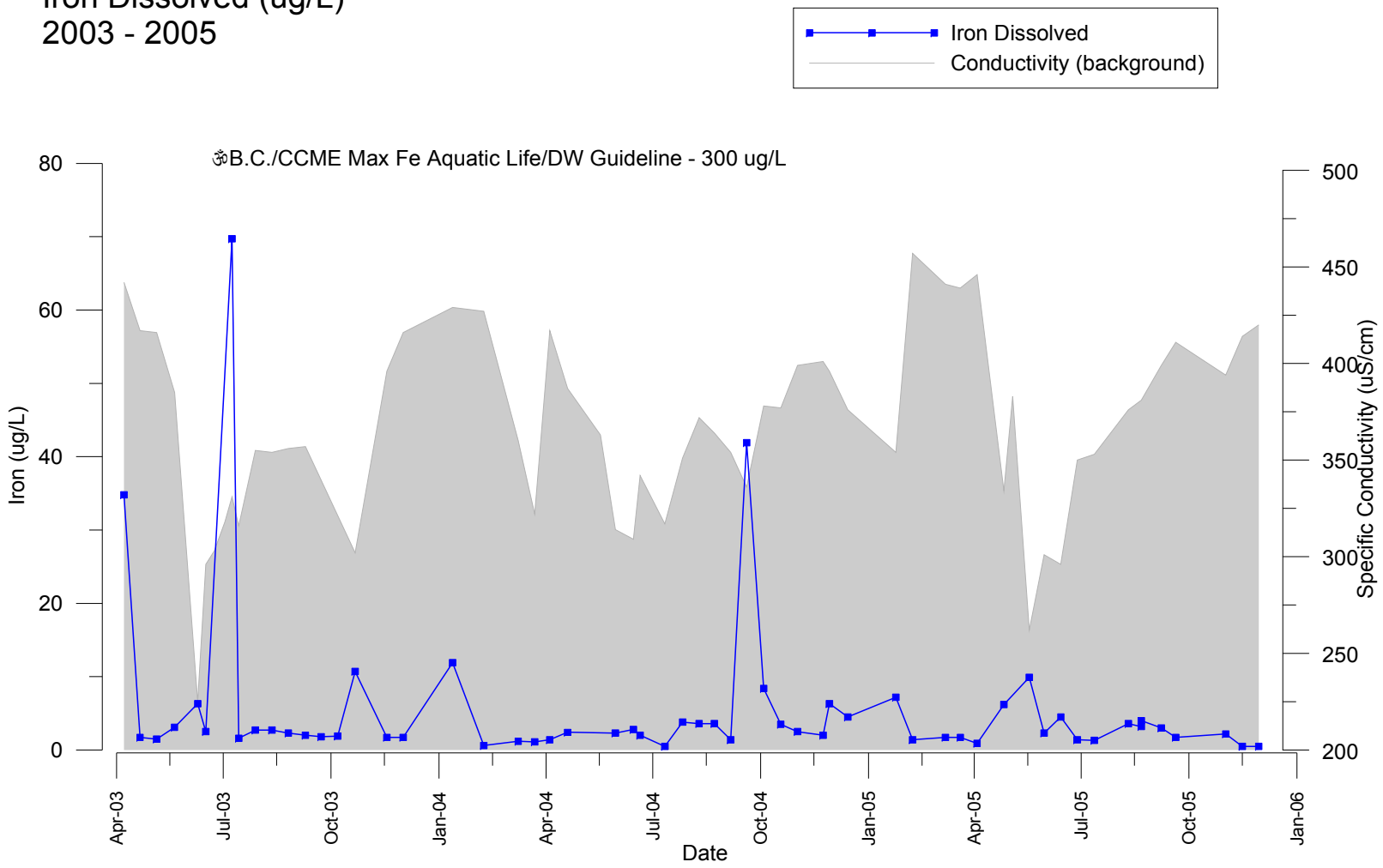

Figure 27
Elk River below Sparwood
Lanthanum Total and Dissolved (ug/L)

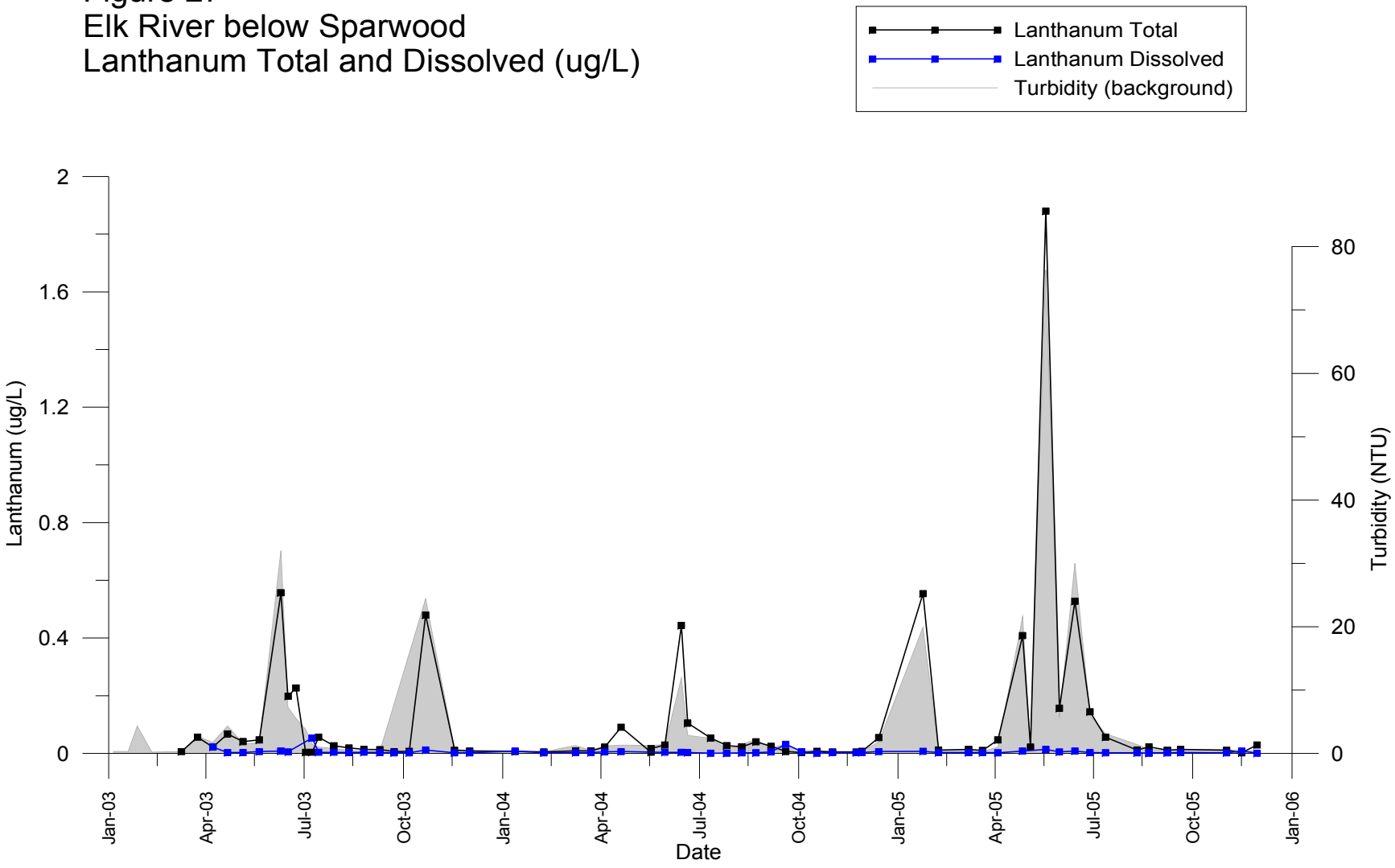

Figure 28
Elk River below Sparwood
Lanthanum Dissolved (ug/L)

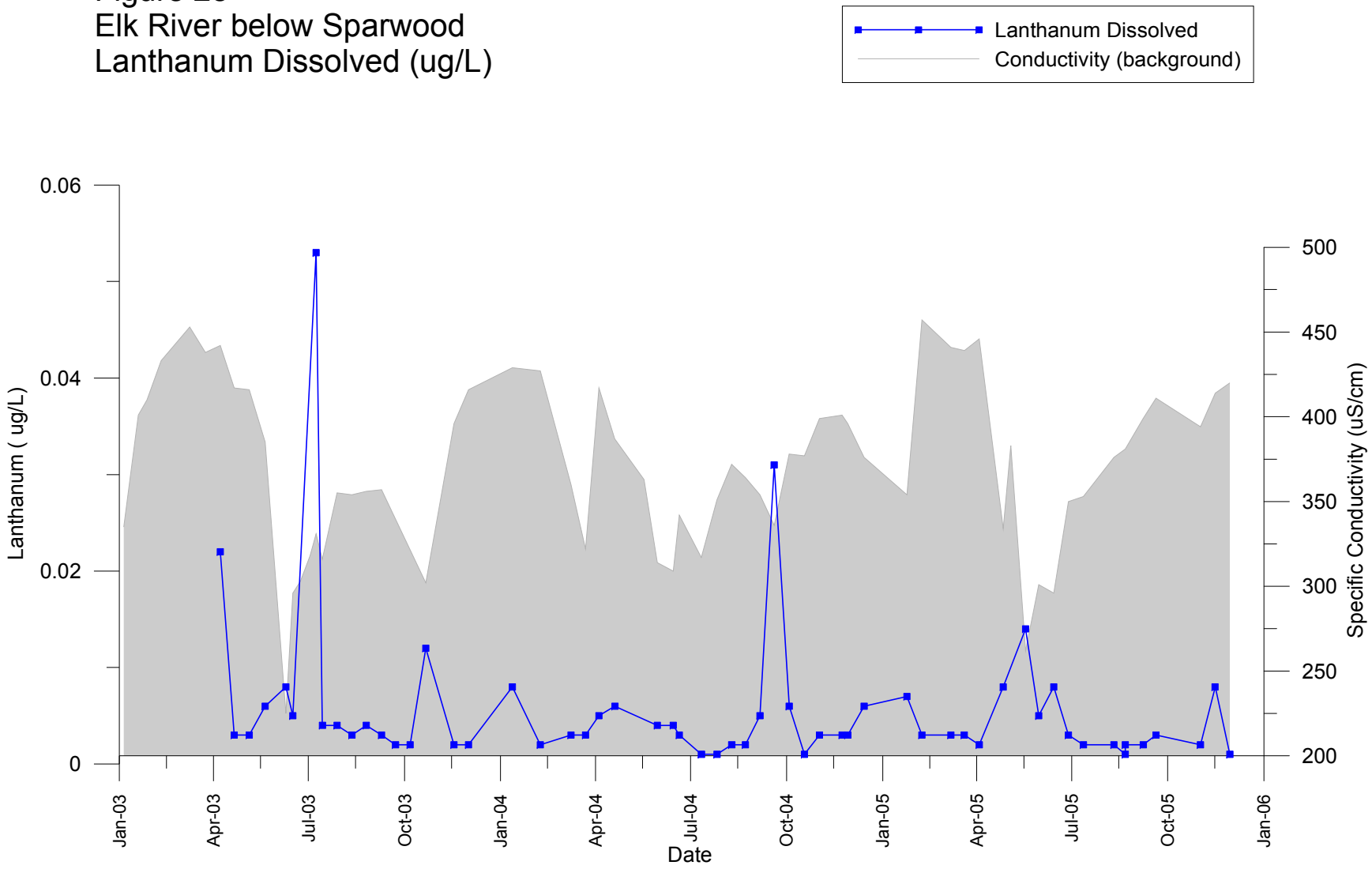

Figure 29
Elk River below Sparwood
Lead Total and Dissolved (ug/L)

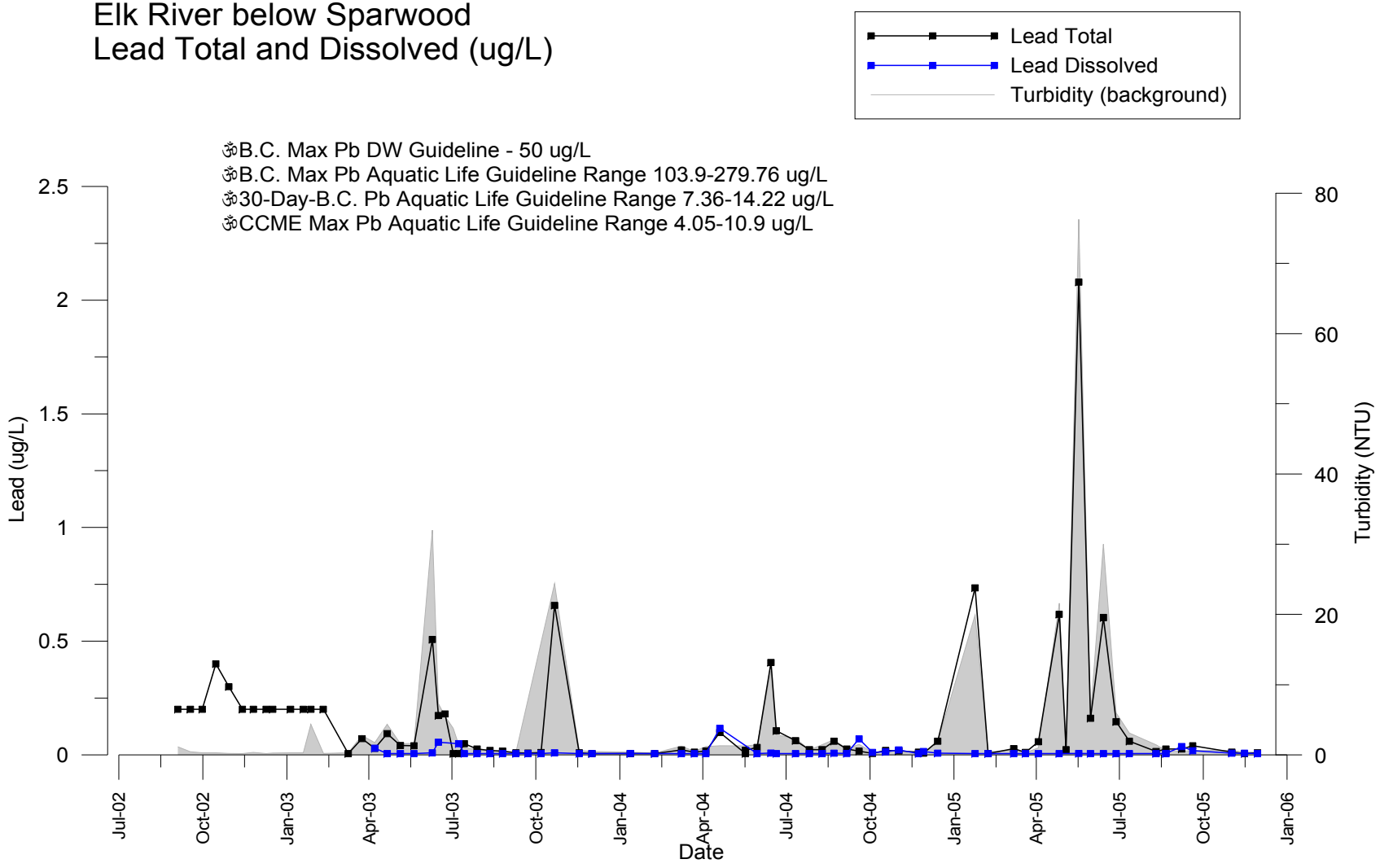

Figure 30
Elk River below Sparwood
Lead Dissolved (ug/L)
2003 - 2005

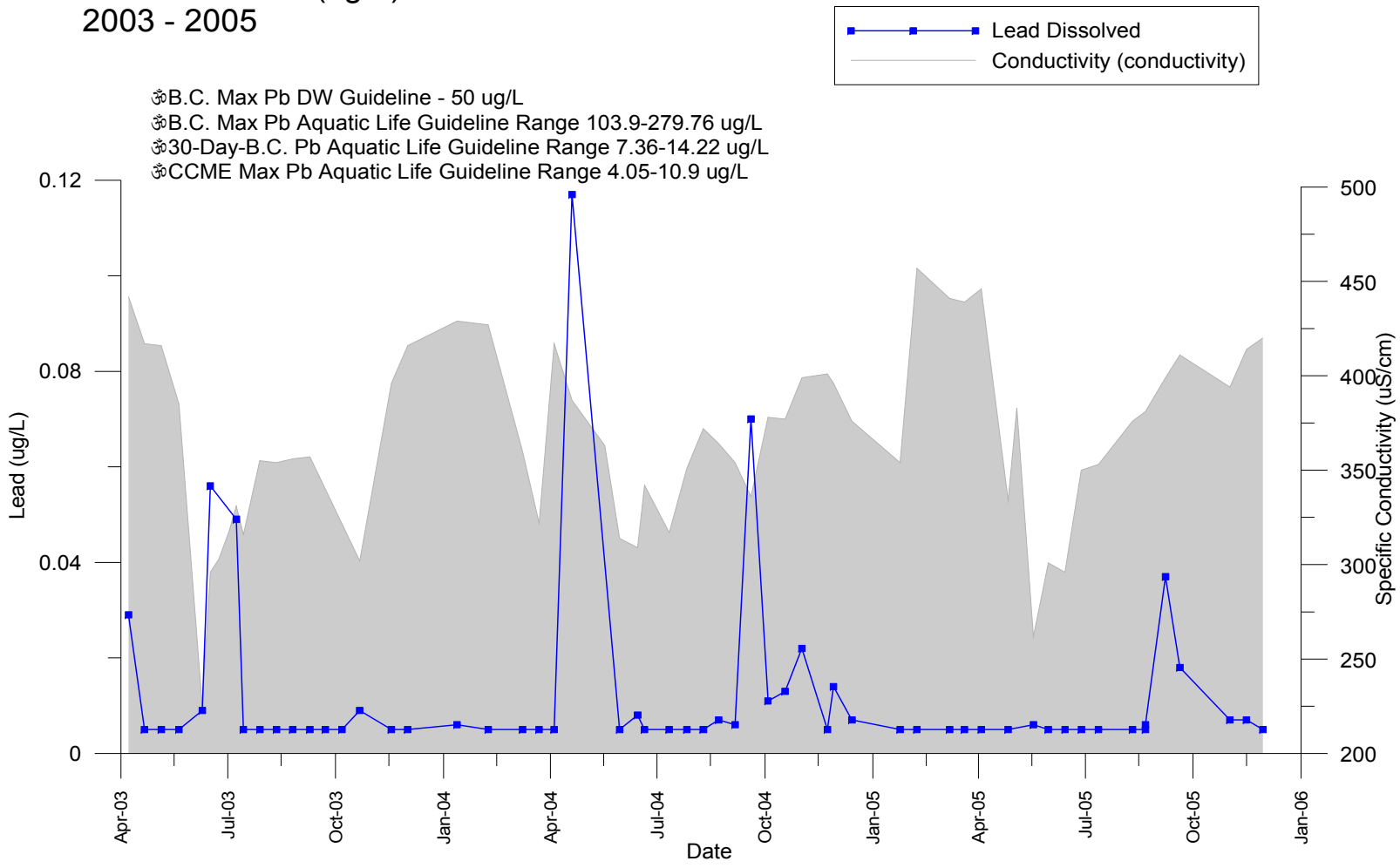

Figure 31
Elk River below Sparwood
Lithium Total and Dissolved (ug/L)

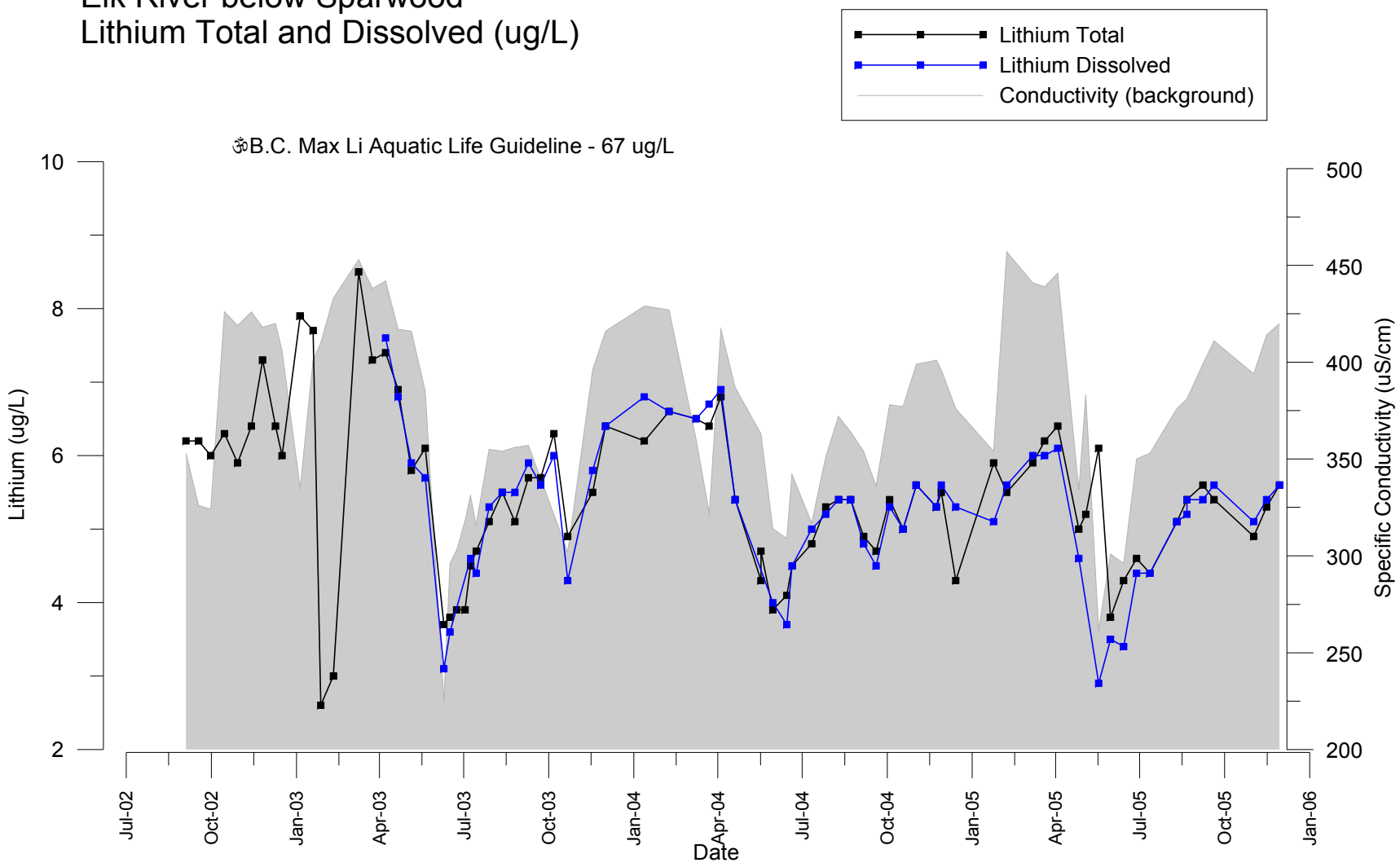

Figure 32
Elk River below Sparwood
Magnesium Dissolved (mg/L)

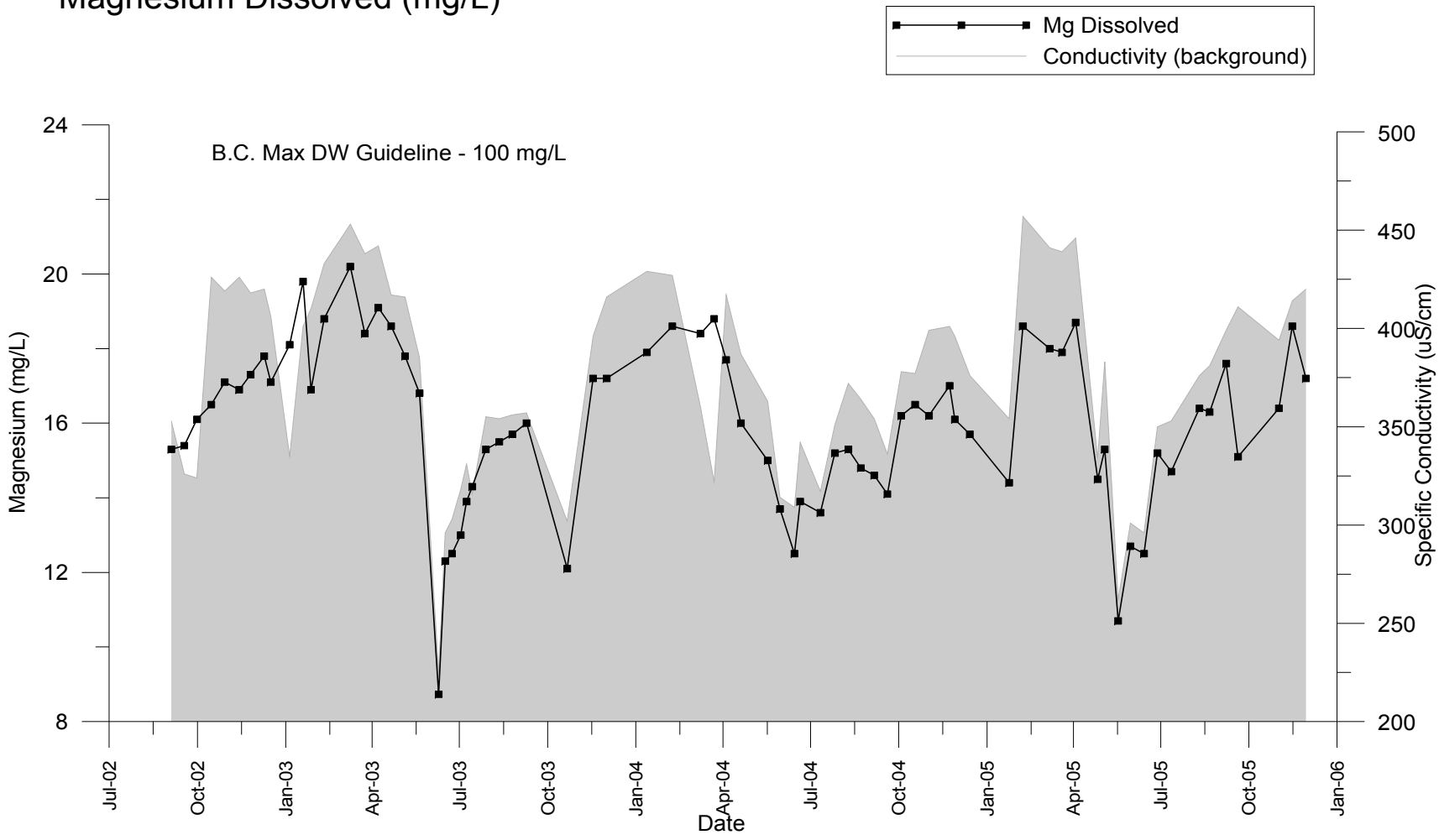

Figure 33
Elk River below Sparwood
Manganese Total and Dissolved (ug/L)

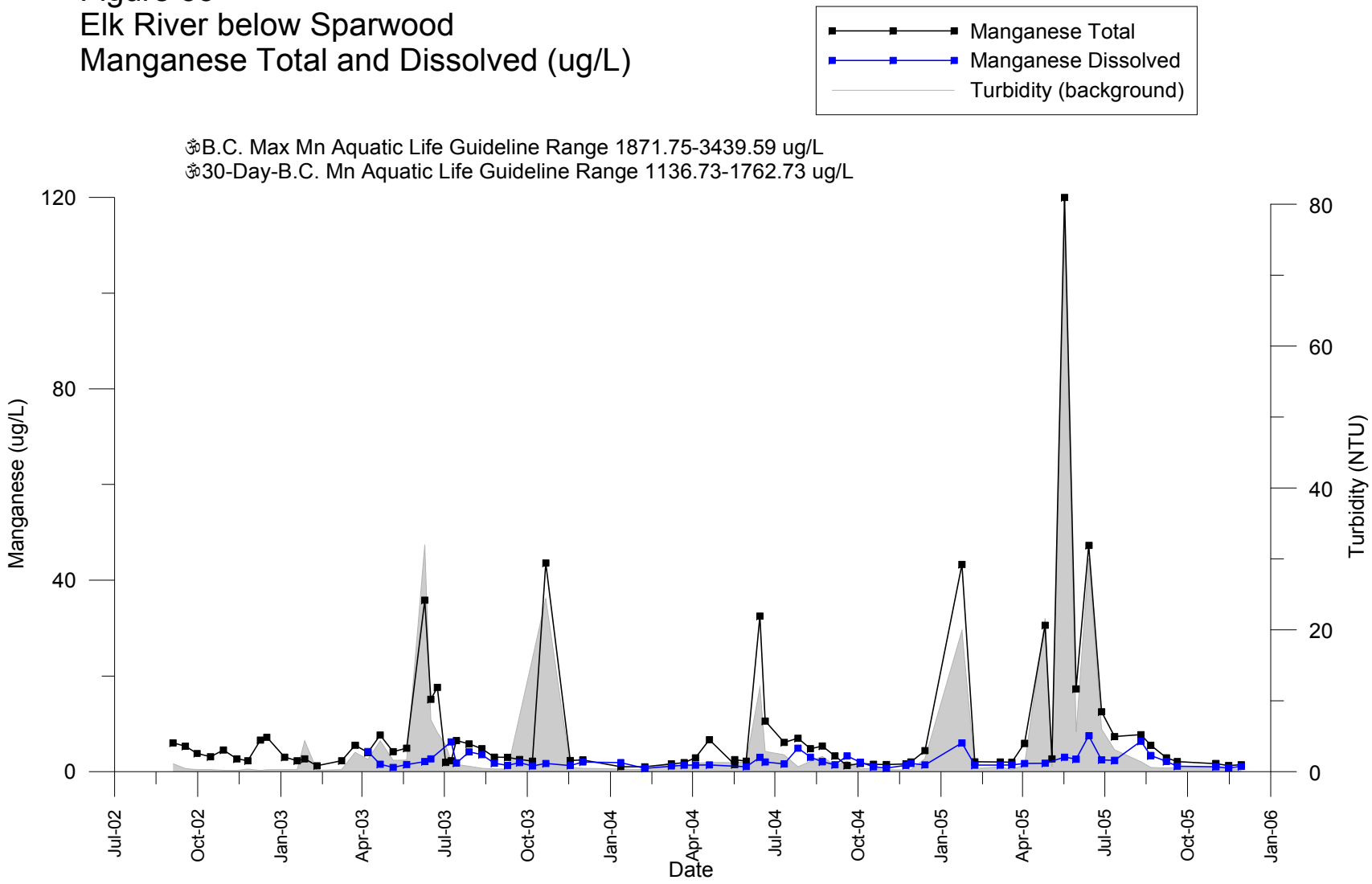

Figure 34
Elk River below Sparwood
Molybdenum Total and Dissolved (ug/L)

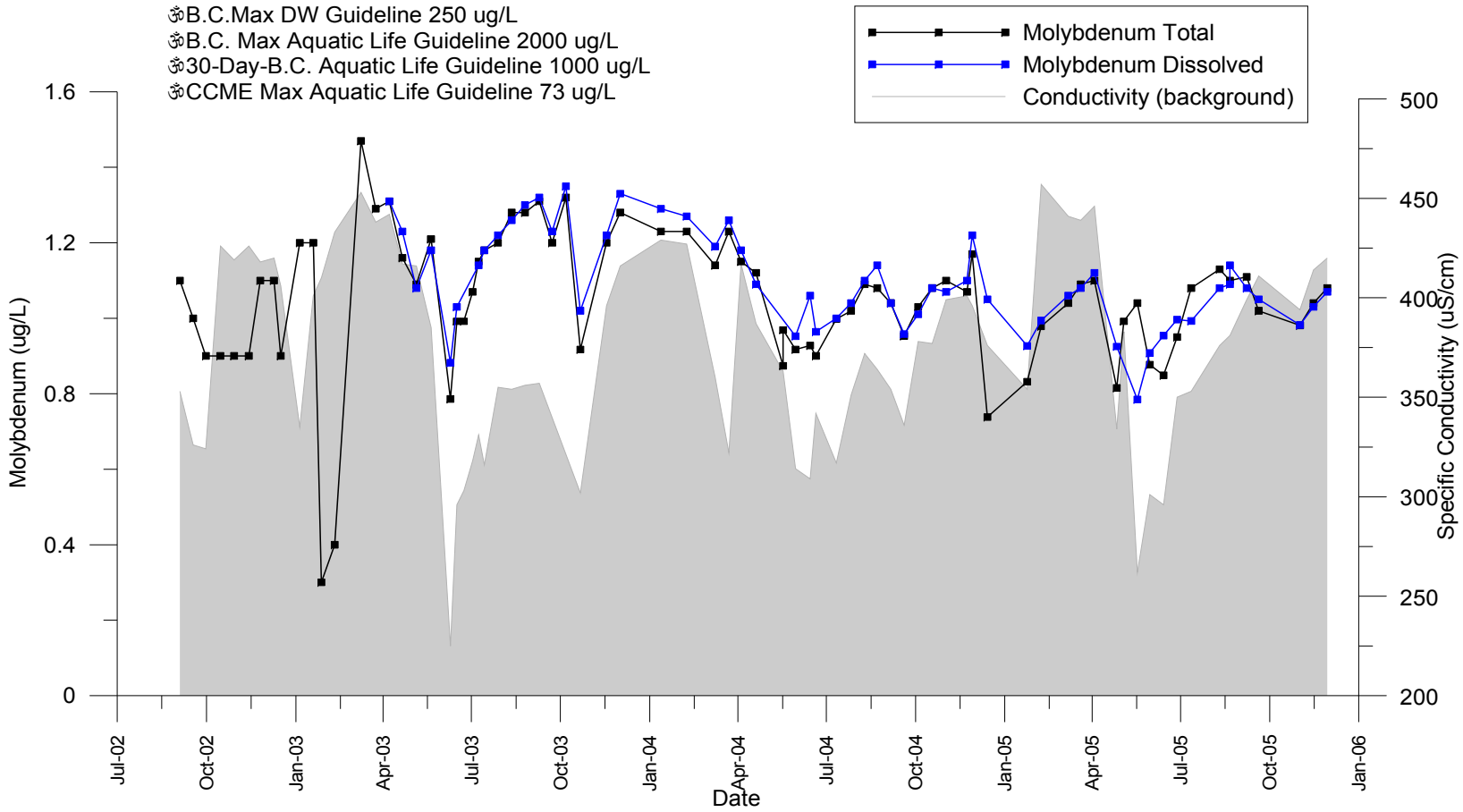

Figure 35
Elk River below Sparwood
Nickel Total and Dissolved (ug/L)

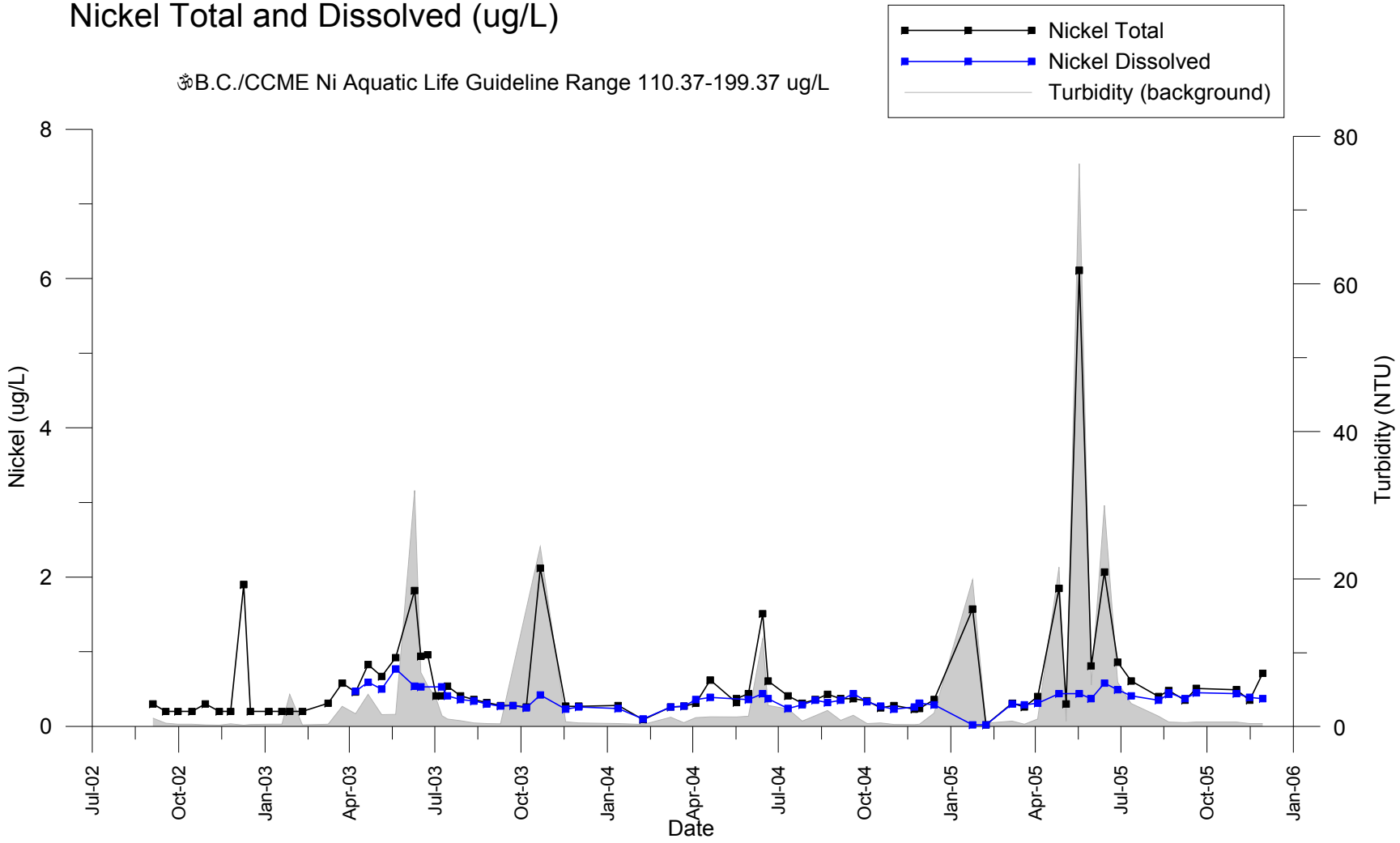

Figure 36
Elk River below Sparwood
Nitrogen Dissolved NO3 and NO2

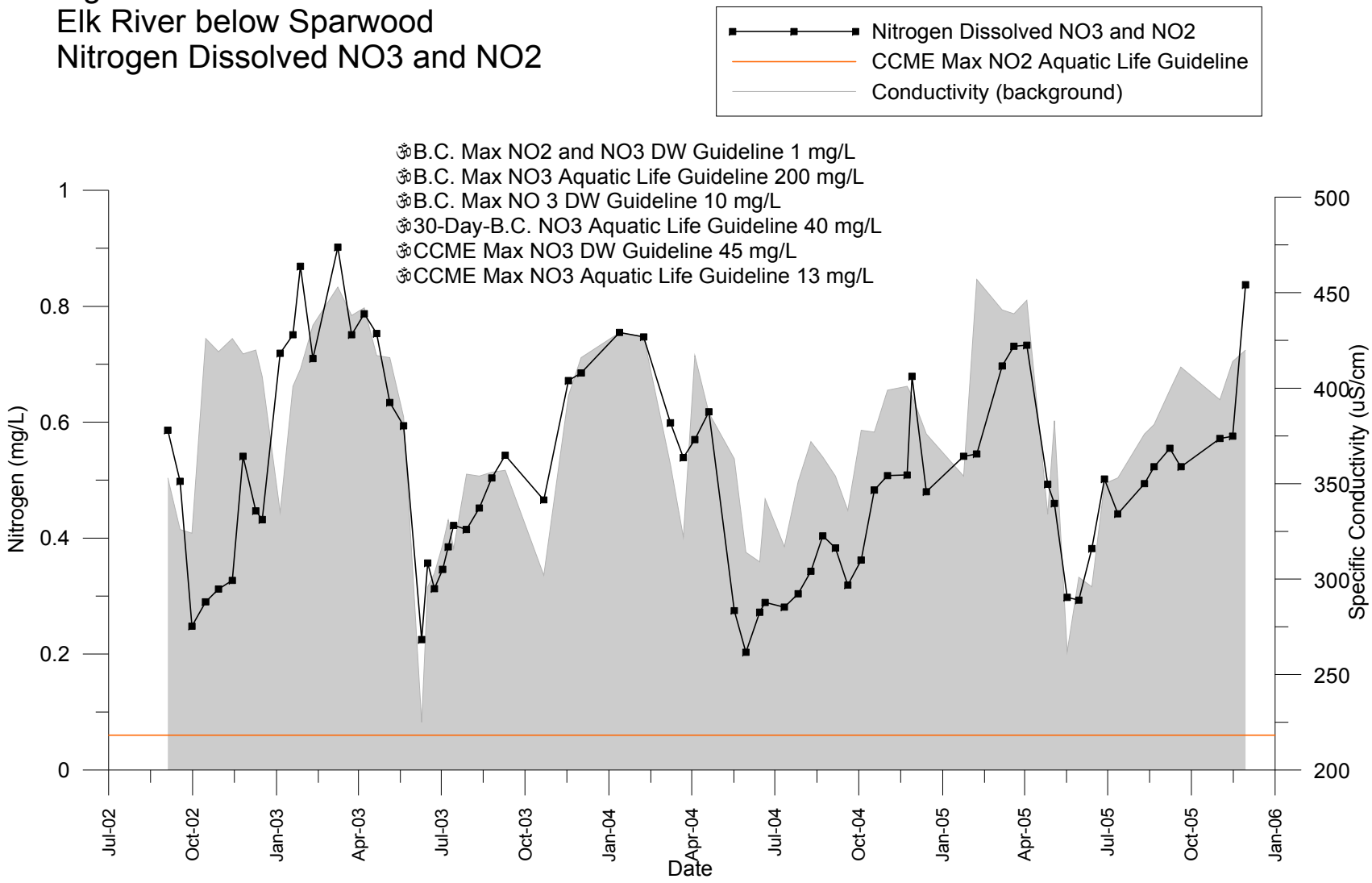

Figure 37
Elk River below Sparwood
Nitrogen Total Dissolved (mg/L)
2002 - 2006

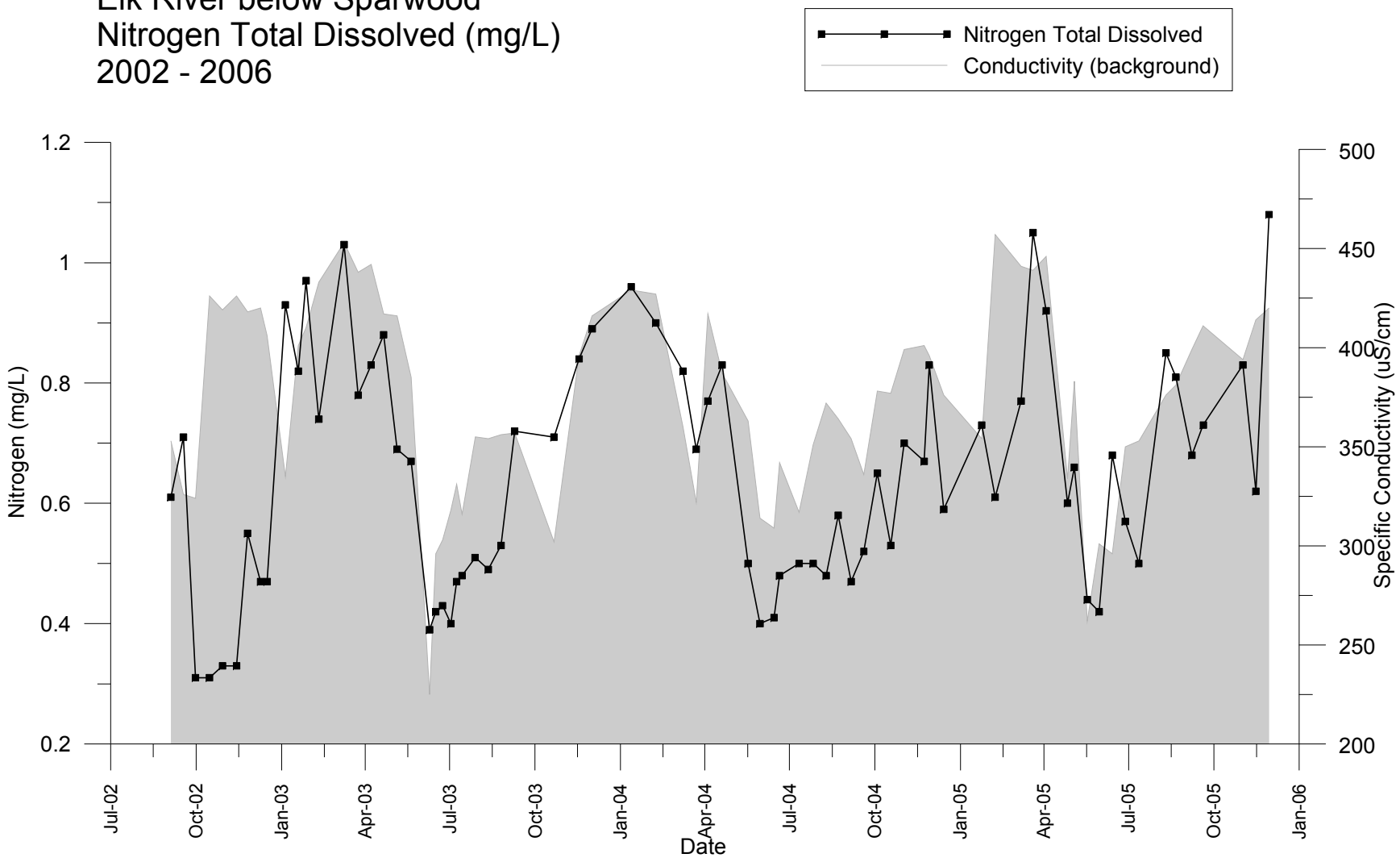

Figure 38
Elk River below Sparwood
pH

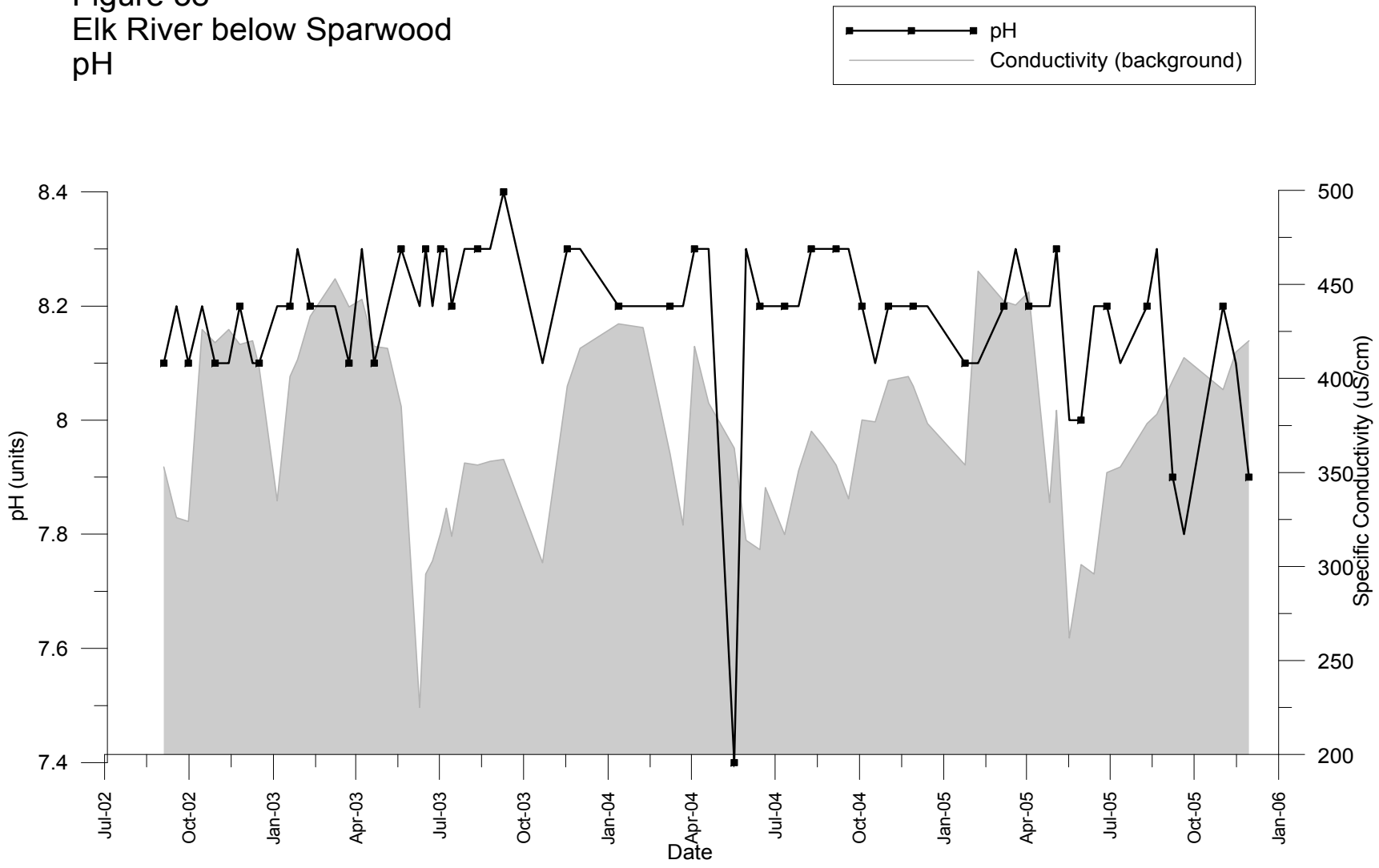

Figure 39
Elk River below Sparwood
Phosphorus Dissolved Ortho

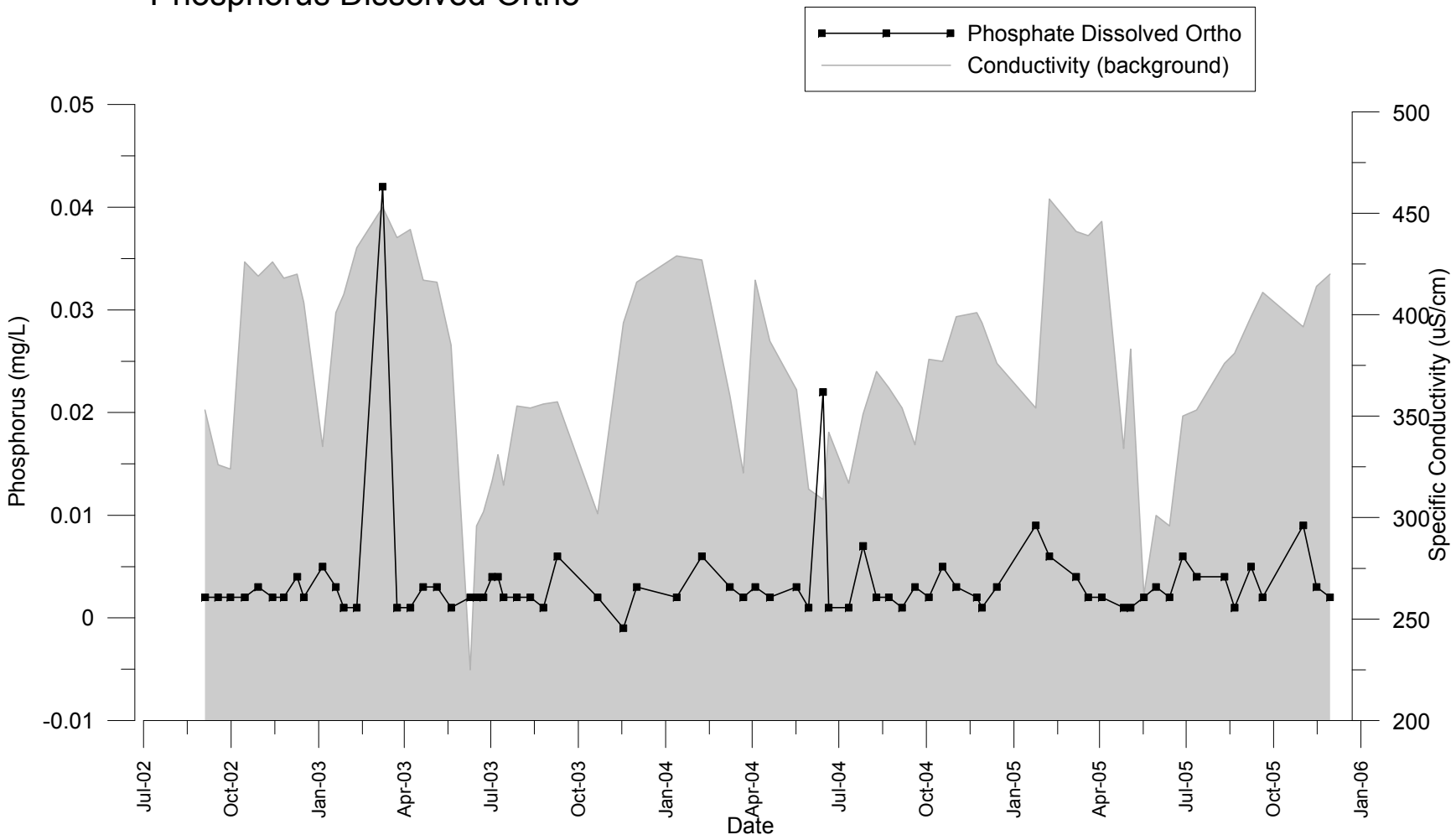

Figure 40
Elk River below Sparwood
Phosphorus Total

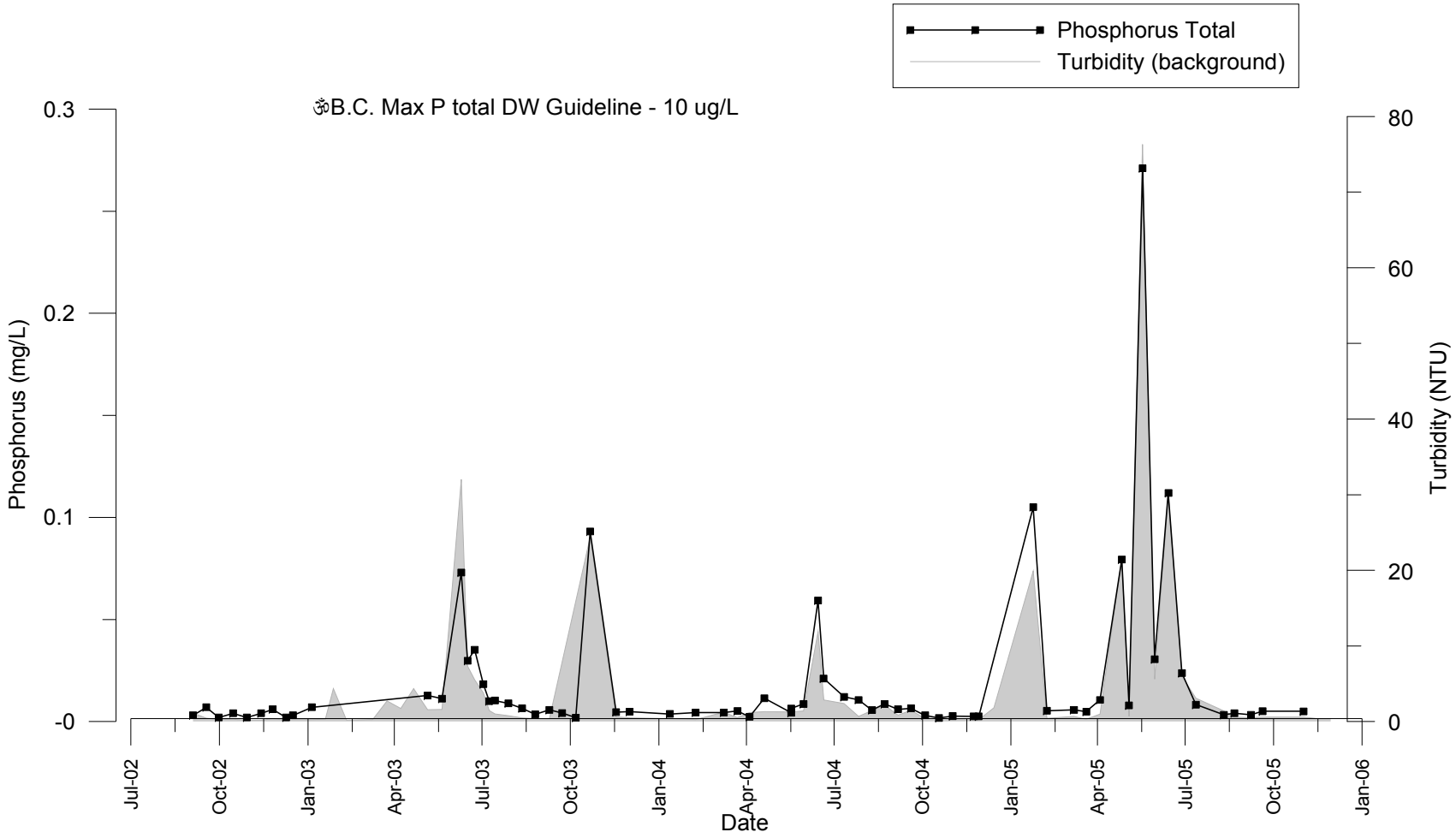

Figure 41
Elk River below Sparwood
Residue Non-Filterable (mg/L)

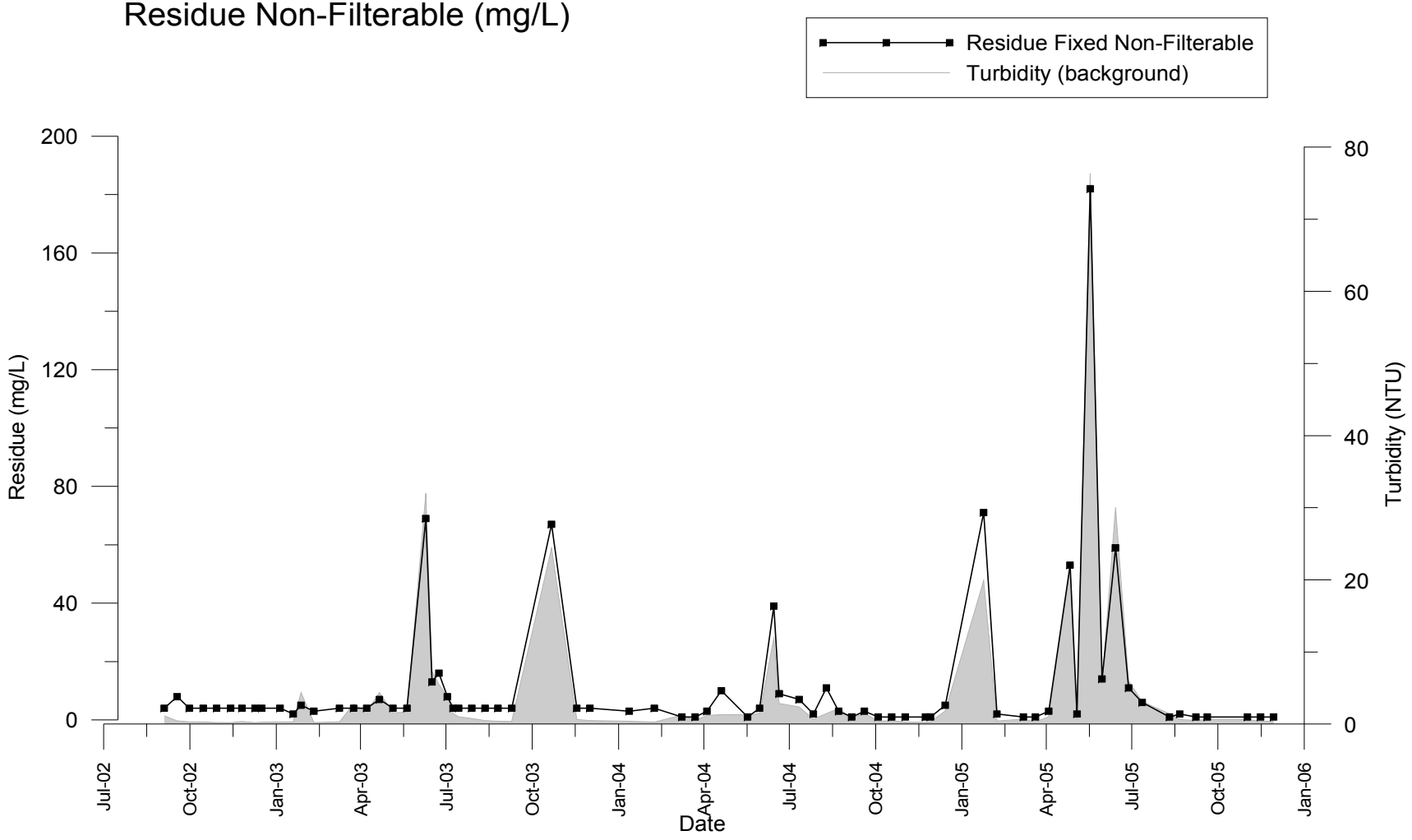

Figure 42
Elk River below Sparwood
Rubidium Total and Dissolved (ug/L)

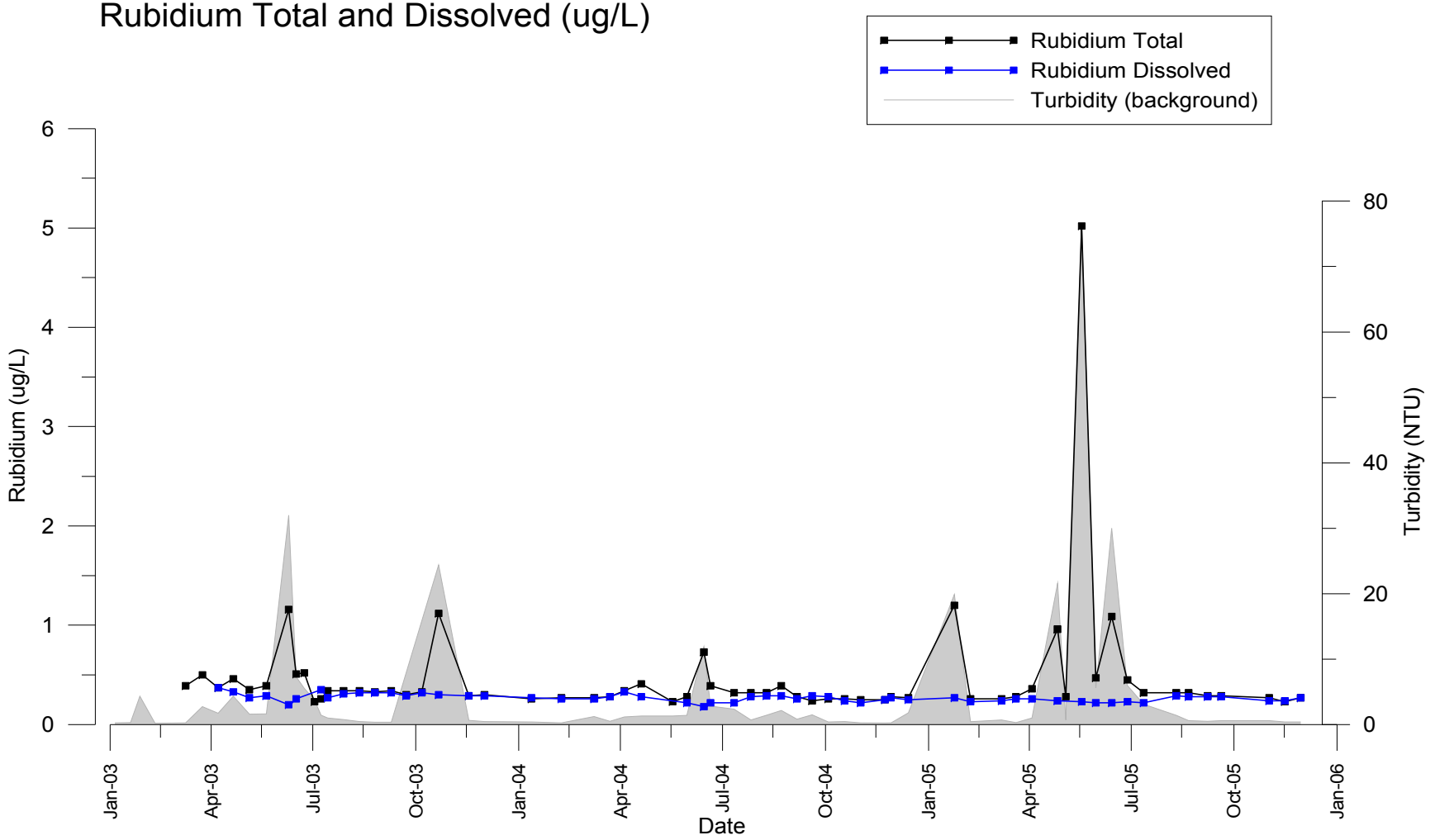

Figure 43
Elk River below Sparwood
Selenium Total and Dissolved (ug/L)

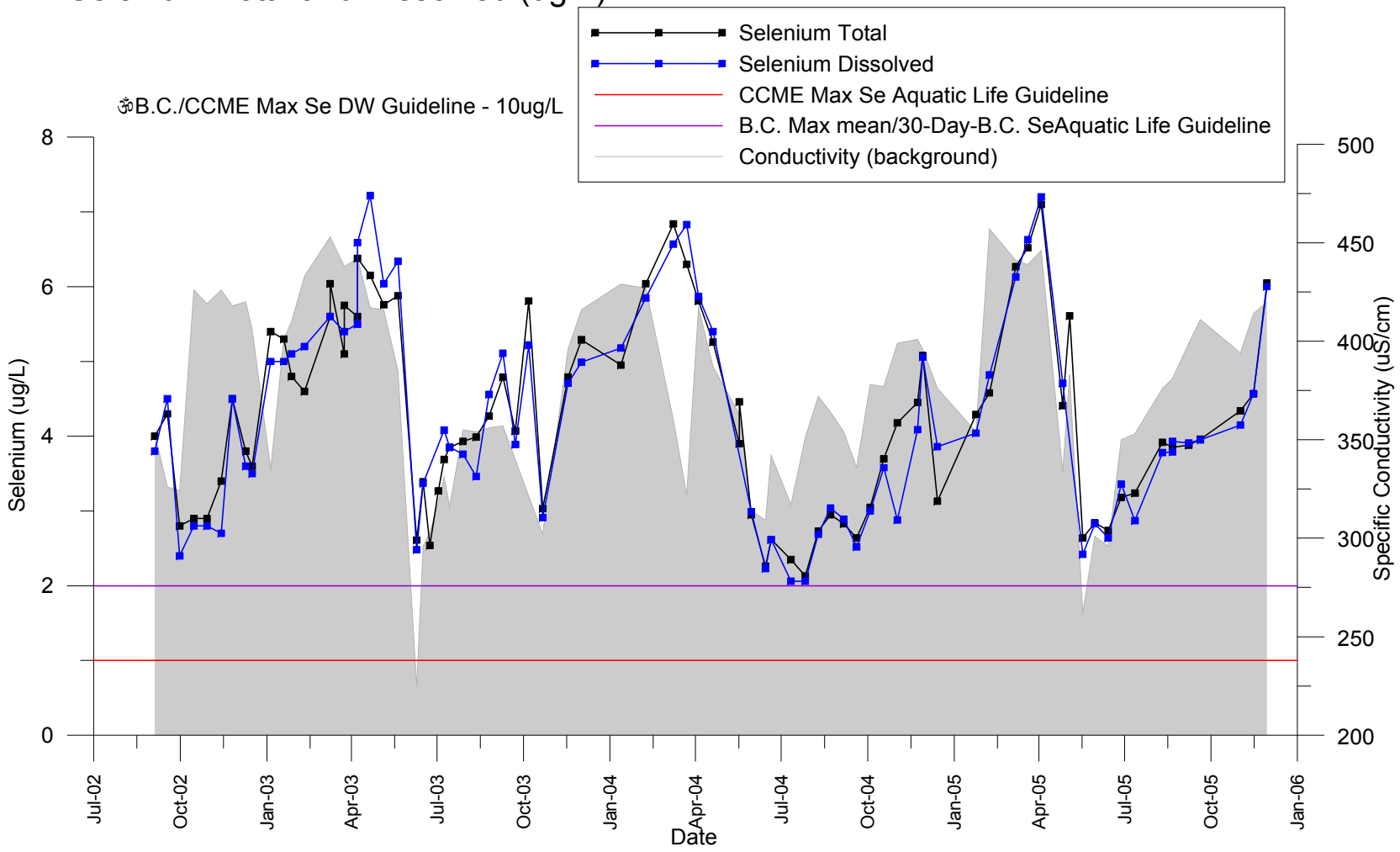

Figure 44
Elk River below Sparwood
Silver Total and Dissolved (ug/L)

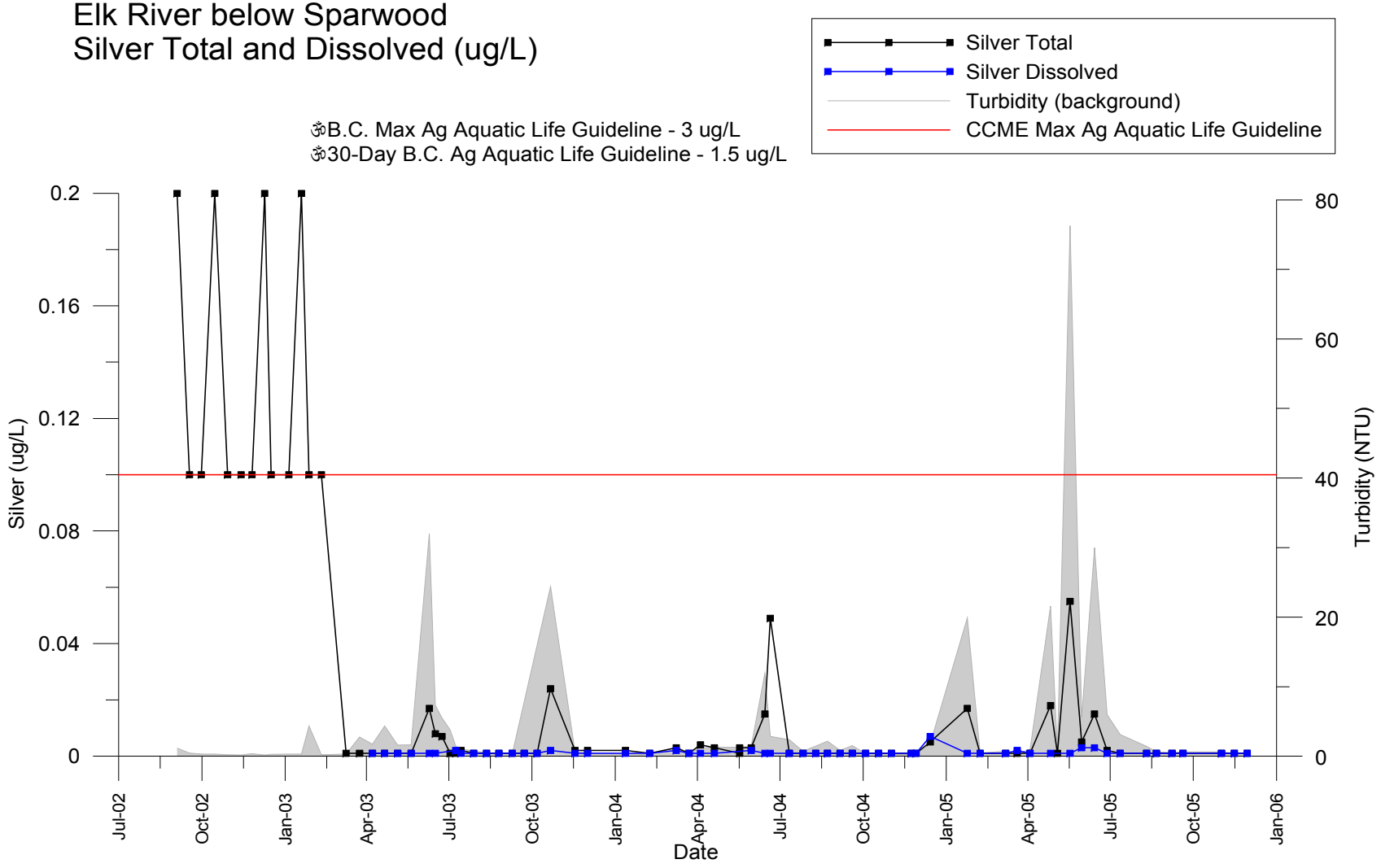

Figure 45
Elk River below Sparwood
Specific Conductivity (uS/cm)

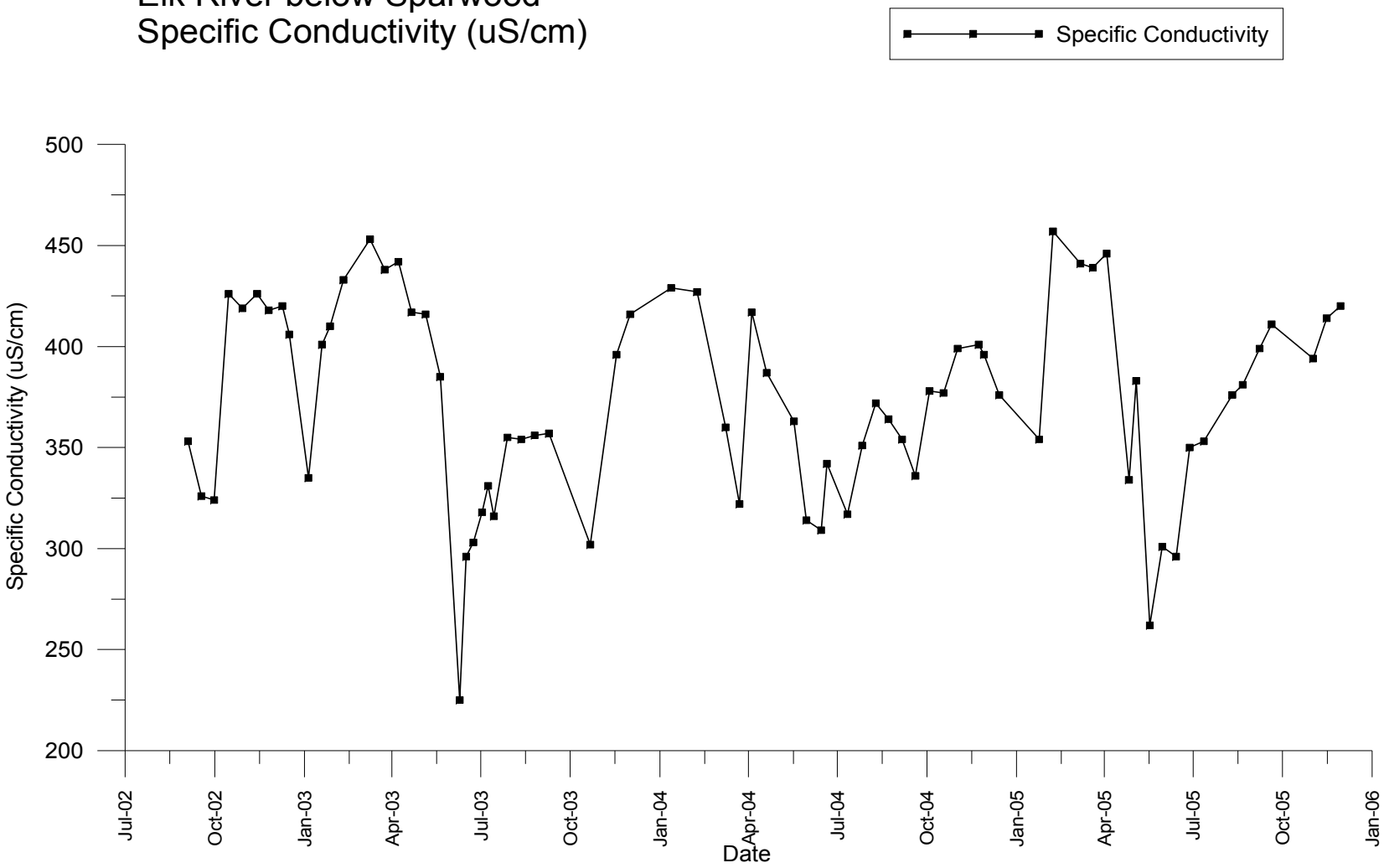

Figure 46
Elk River below Sparwood
Strontium Total and Dissolved (ug/L)

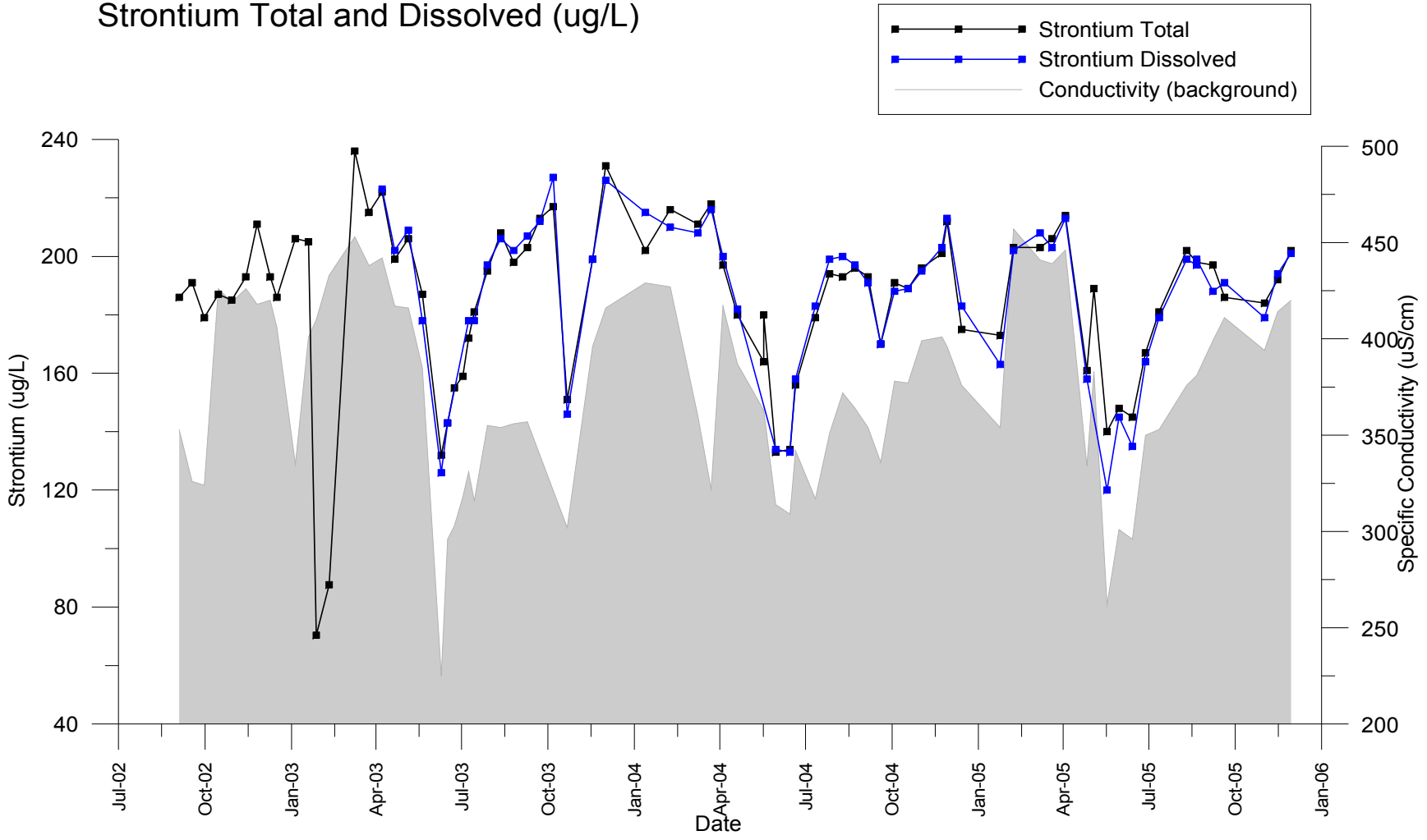

Figure 47
Elk River below Sparwood
Sulphate Dissolved (mg/L)

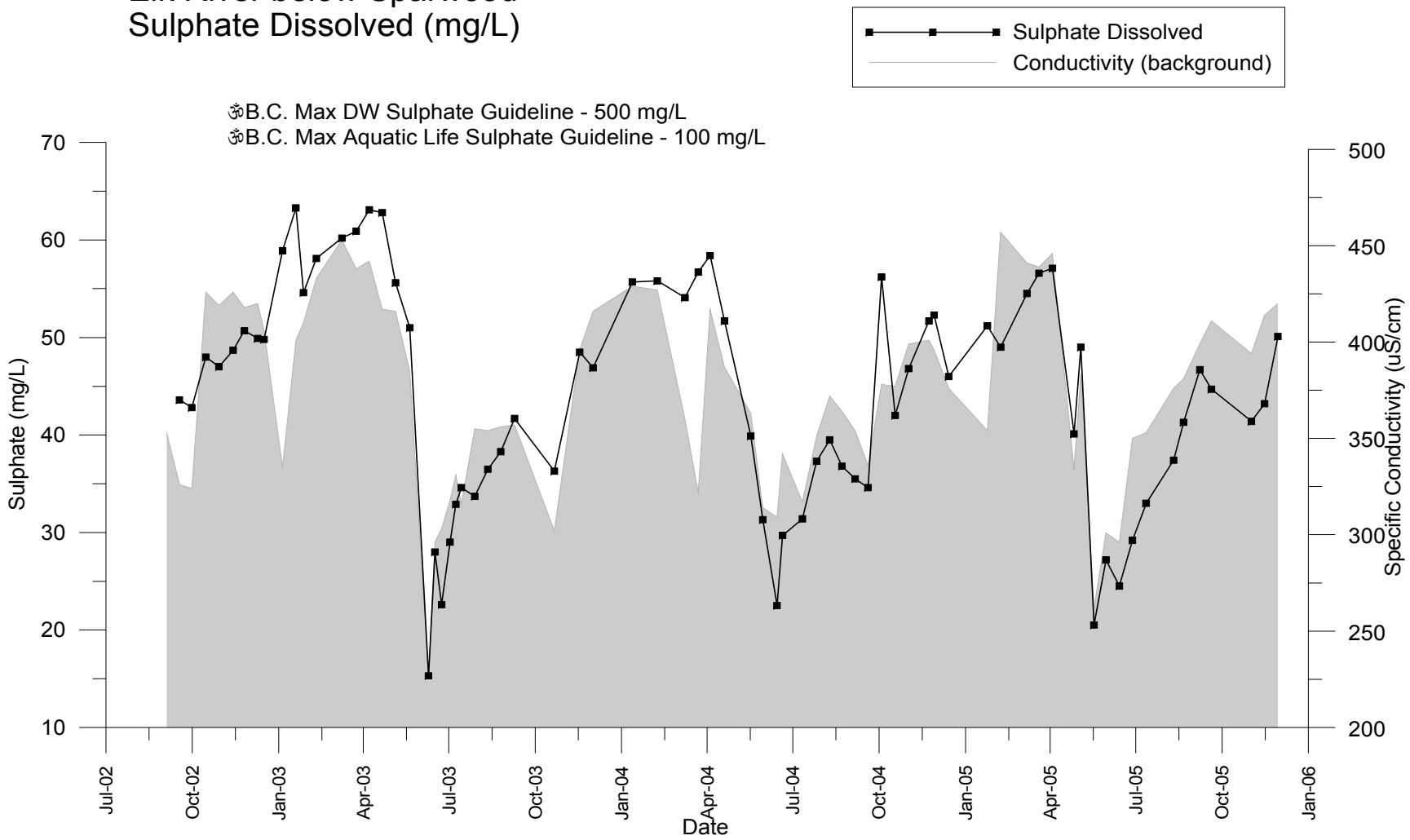

Figure 48
Elk River below Sparwood
Temperature Air and Water (deg C)

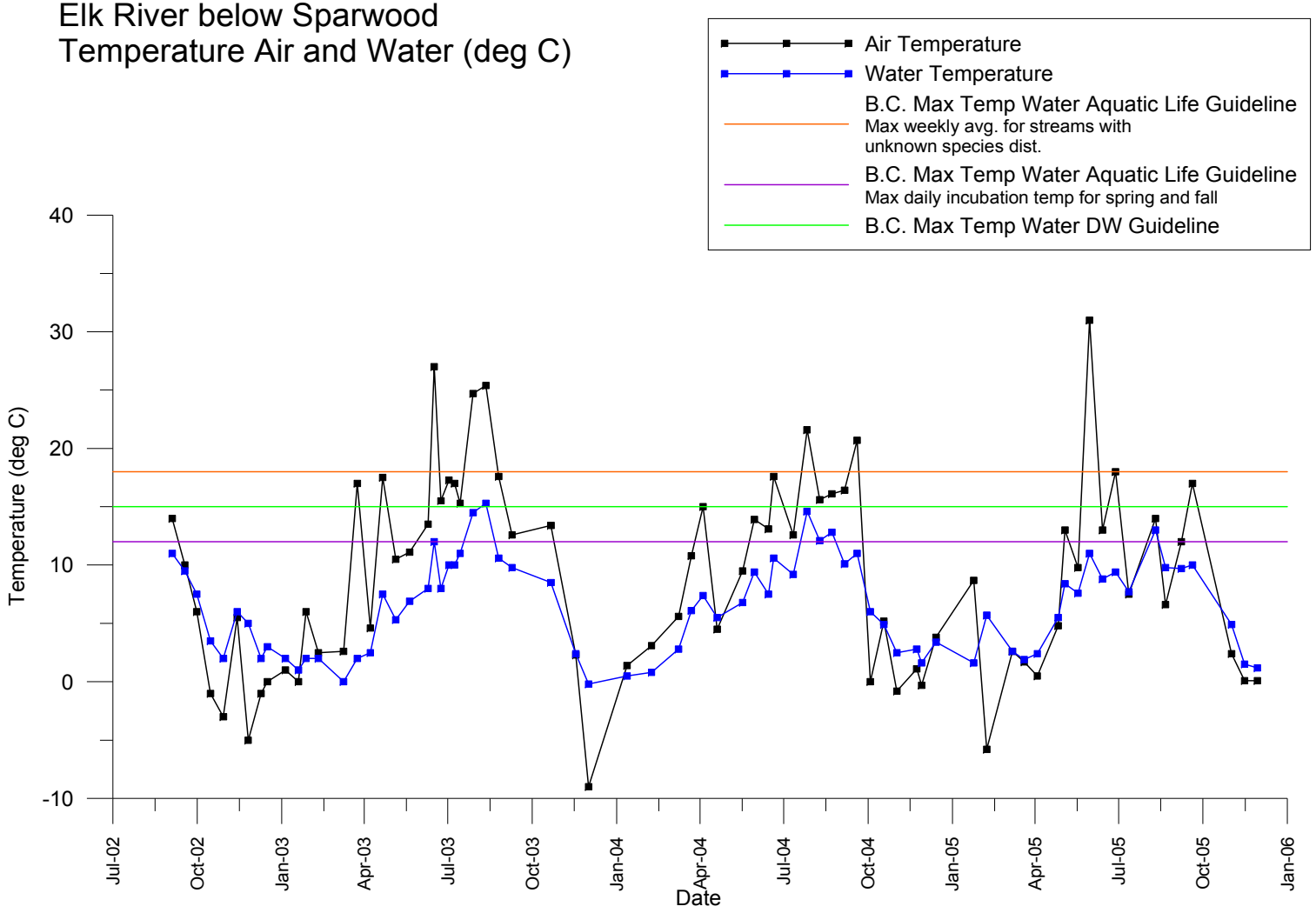

Figure 49
Elk River below Sparwood
Thallium Total and Dissolved (ug/L)

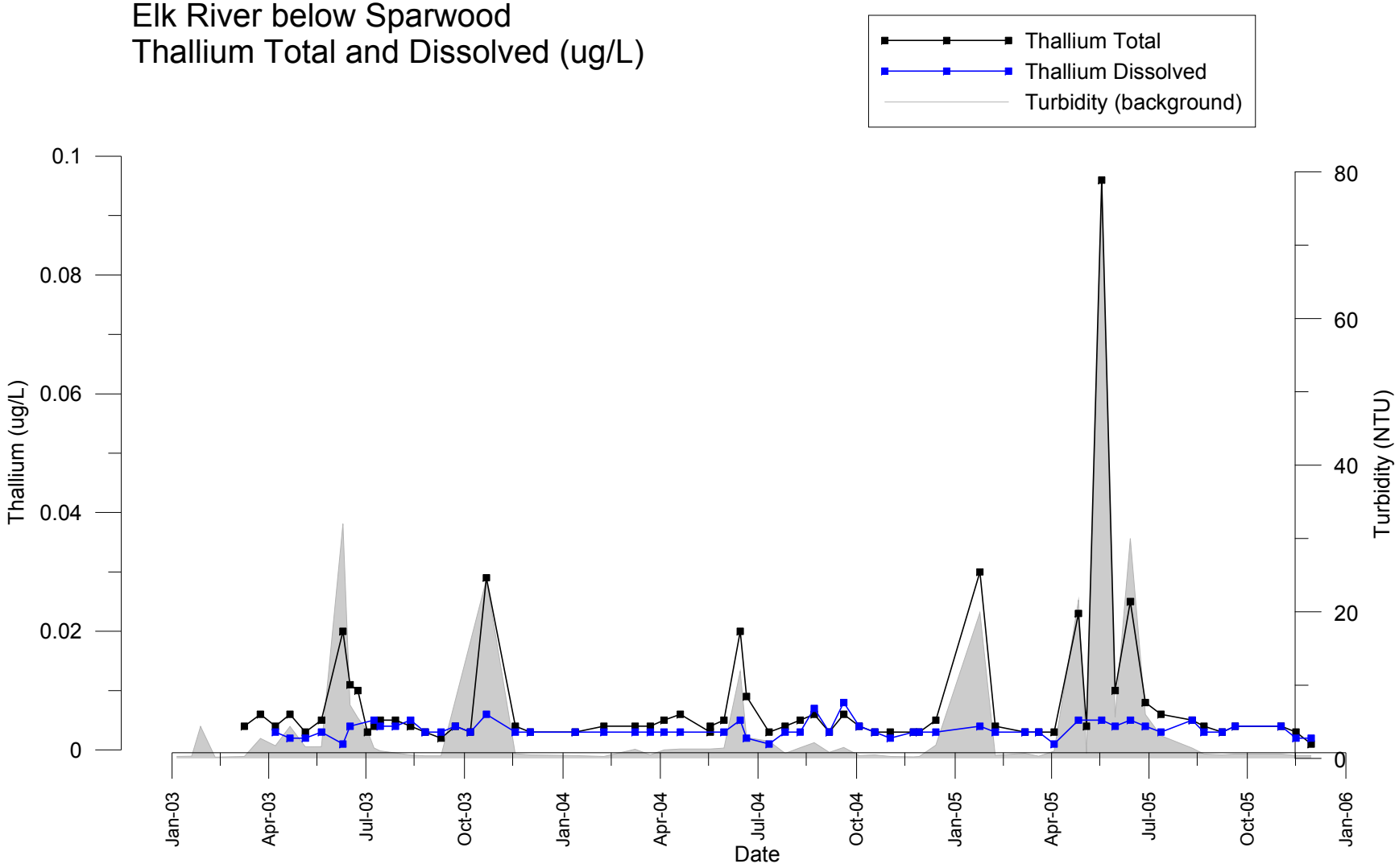

Figure 50
Elk River below Sparwood
Tin Total (ug/L)

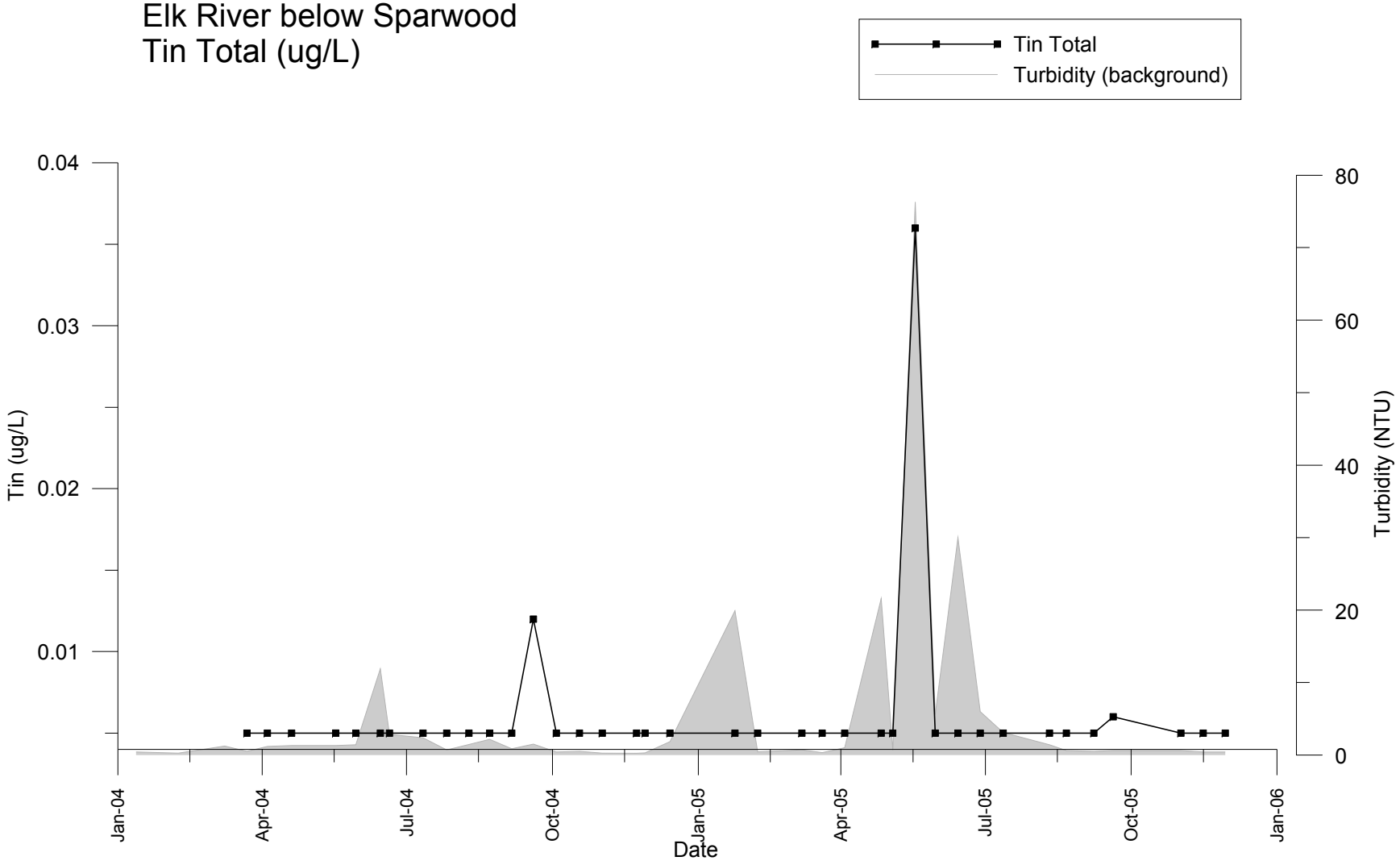

Figure 51
Elk River below Sparwood
Turbidity

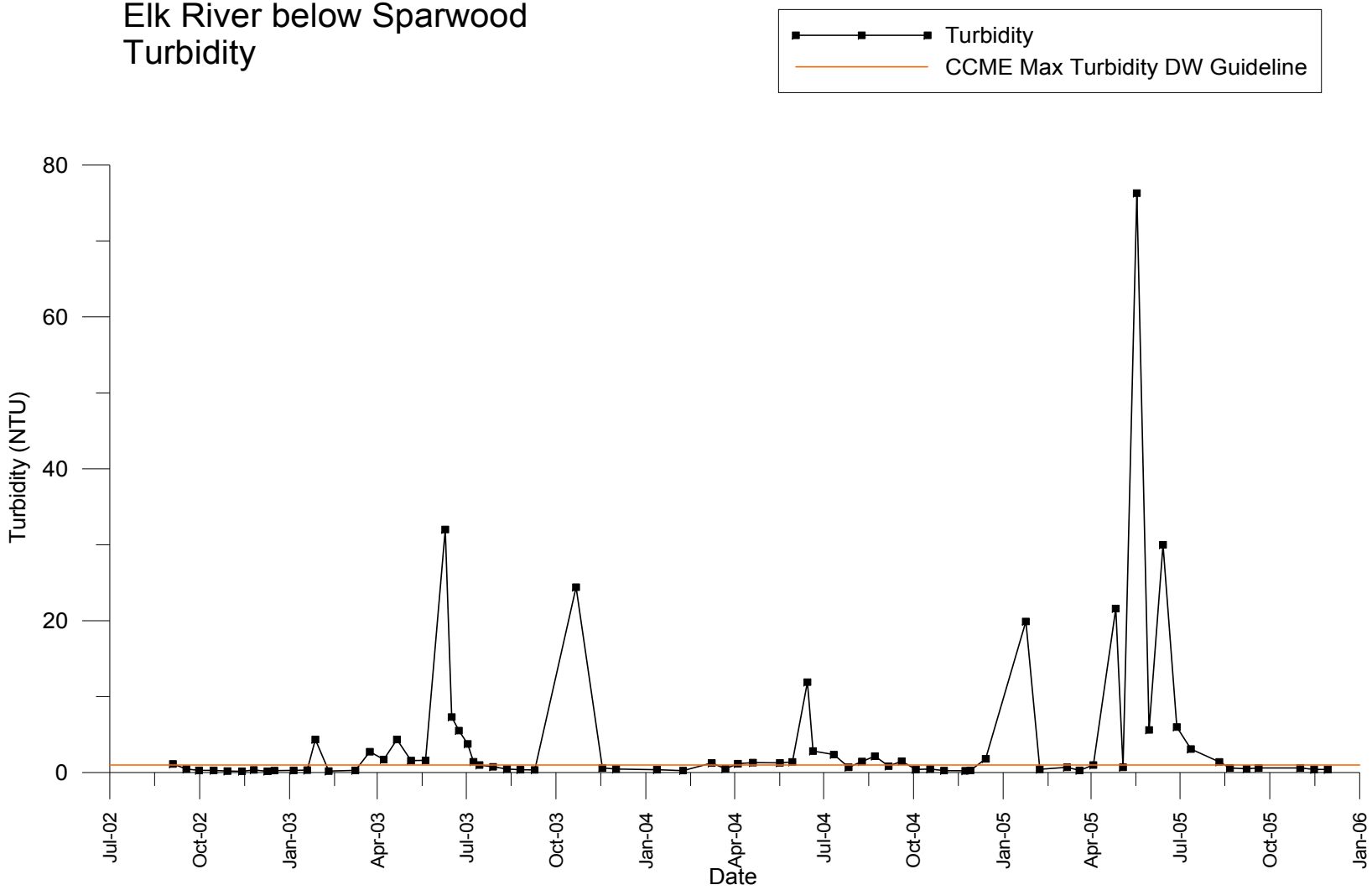

Figure 52
Elk River below Sparwood
Uranium Total and Dissolved (ug/L)

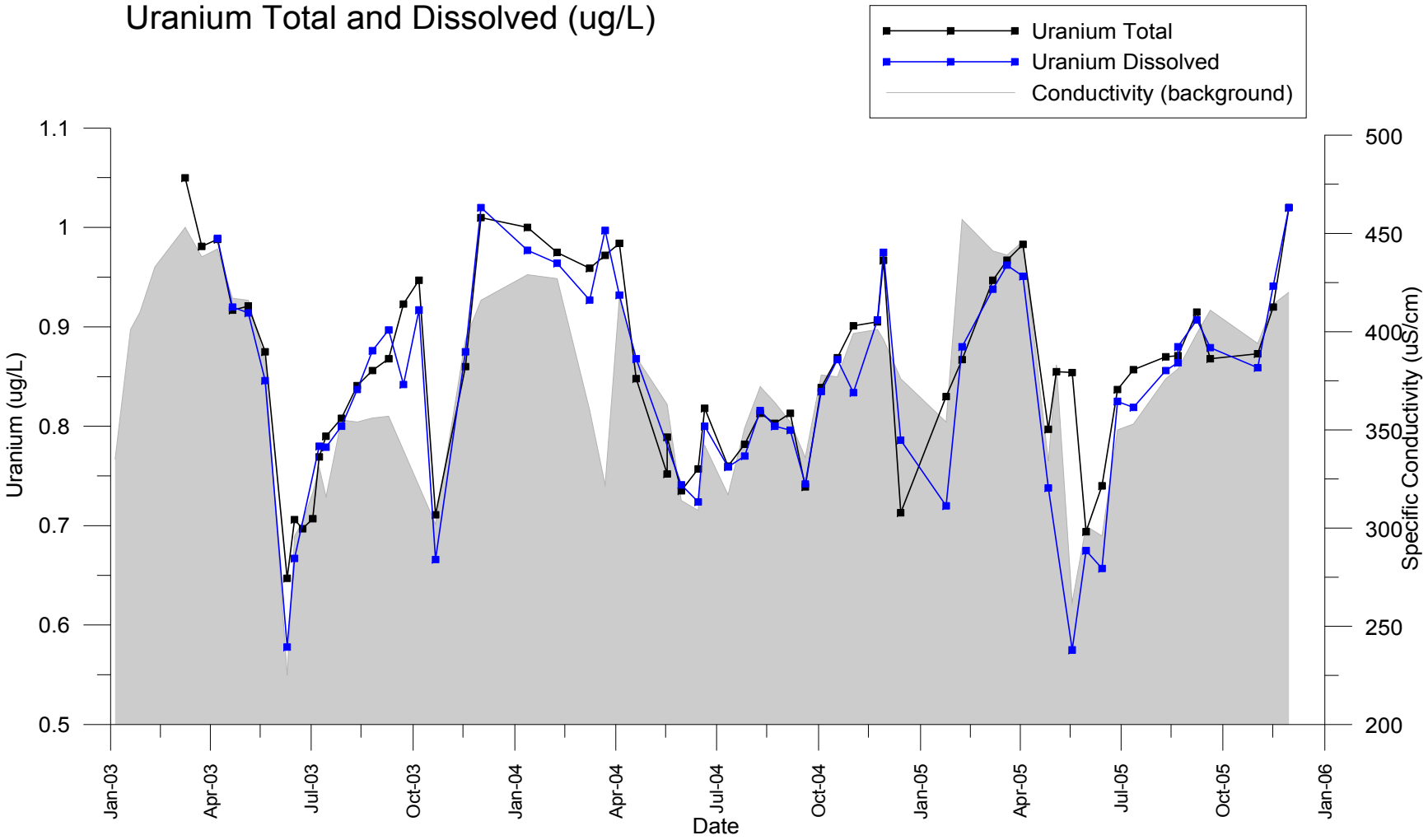

Figure 53
Elk River below Sparwood
Vanadium Total Dissolved (ug/L)

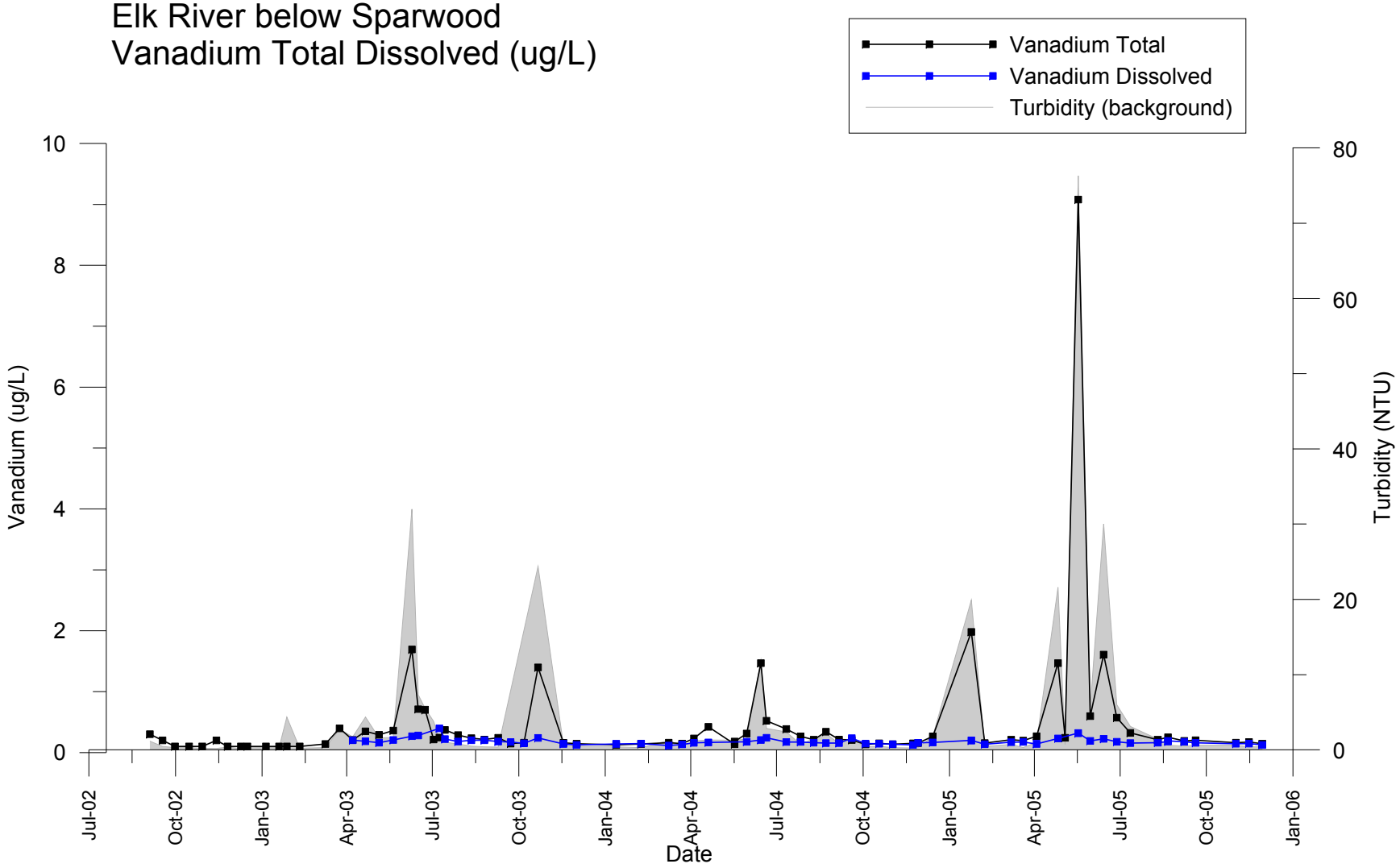

Figure 54
Elk River below Sparwood
Vanadium Dissolved (ug/L)

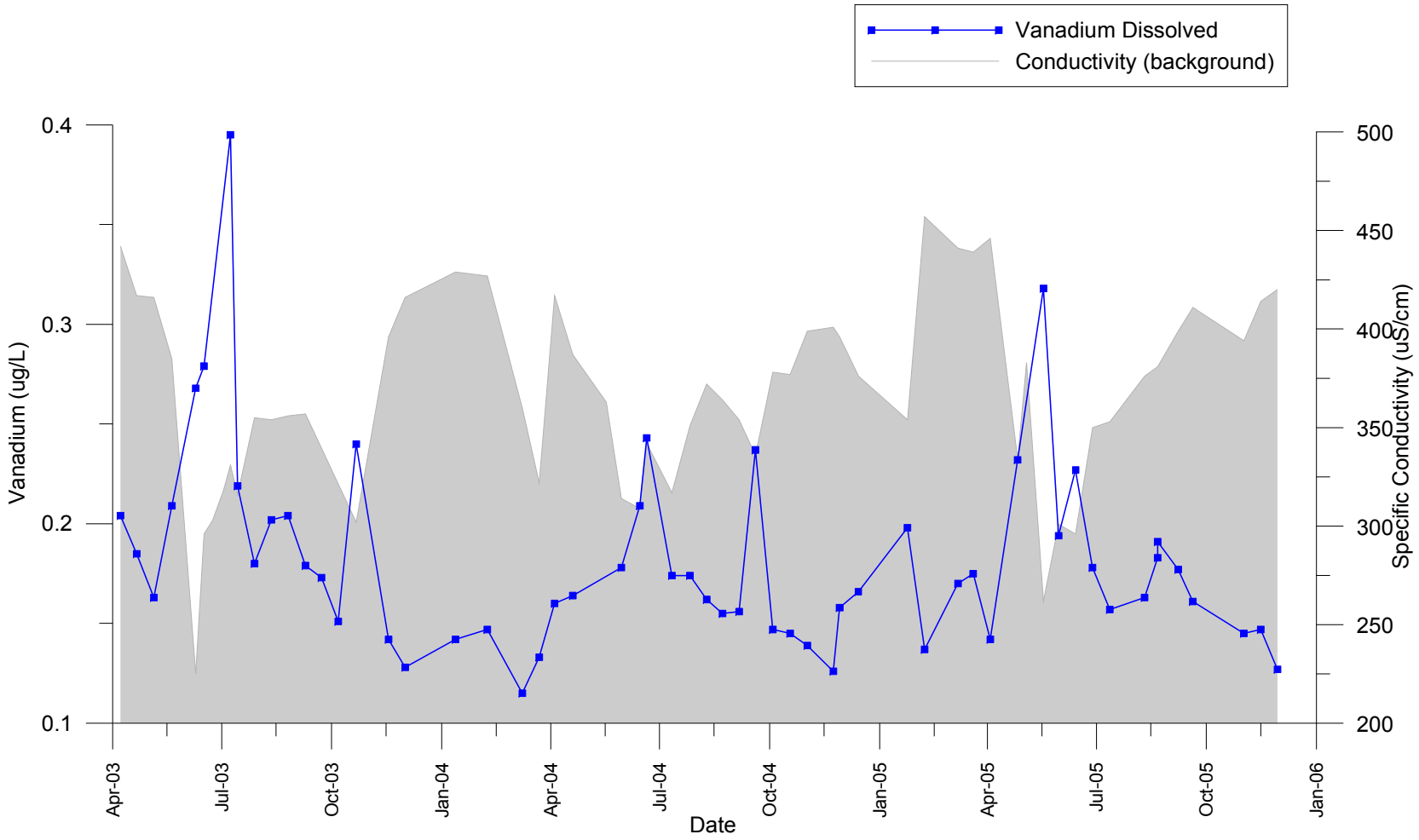

Figure 55
Elk River below Sparwood
Zinc Total and Dissolved (ug/L)