CANADA – BRITISH COLUMBIA
WATER QUALITY MONITORING AGREEMENT

WATER QUALITY ASSESSMENT OF THOMPSON RIVER AT SPENCES BRIDGE (1985 – 2000)

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EXECUTIVE SUMMARY

This report assesses the long-term water quality trends of the Thompson River at Spences Bridge. The Thompson River watershed, which has a drainage area in excess of 55,000 km^2, occupies a significant portion of southern British Columbia. It encompasses the North Thompson, the South Thompson, and the lower Thompson rivers, and is a major tributary of the Fraser River. The lower Thompson River originates at Kamloops, at the confluence of the North and South Thompson rivers, and flows for approximately 160 km before emptying into the Fraser River at Lytton. Water quality has been monitored on the Thompson River at Spences Bridge since 1985. Five other long-term water quality monitoring stations within the Thompson River watershed are: the North Thompson at North Kamloops, the South Thompson at Kamloops, the Bonaparte River near the mouth, Salmon River at Highway #1 Bridge (at Salmon Arm), and the Nicola River at Spences Bridge.

The plotted data were compared to water quality objectives for the Thompson River and to British Columbia's approved and working guidelines for water quality. Of special interest were water quality levels and trends that may have been harmful to sensitive water uses including drinking water, aquatic life, wildlife, recreation, irrigation, and livestock watering.

CONCLUSIONS

- Levels of adsorbable organic halides (AOX), chloride, dioxins and furans and sodium have shown a decrease since the early 1990's, as a result waste abatement by the Weyerhaeuser pulp mill in Kamloops.
- Water temperatures frequently exceeded the aesthetic drinking water guideline, but were usually warm enough during the summer months to permit water-contact recreation such as swimming. The water quality guideline for salmonids was also exceeded occasionally during the summer months.
- Turbidity often exceeded drinking water guidelines, especially during annual freshet when higher flows resulted in increased erosion, runoff, and suspended

sediment. There appeared to be an increasing trend in turbidity over time. Treatment to remove the turbidity prior to use as drinking water is necessary.

- During freshet, fairly high levels of phosphorus and many metals (including aluminum, cadmium, chromium, cobalt, copper, iron, manganese and zinc) occurred that exceeded water quality guidelines. However, since these were likely due to elevated suspended sediment levels, they were not necessarily bio-available, and would be reduced by the treatment needed to remove turbidity prior to drinking.
- Indicators of fecal contamination exceeded the objectives to protect raw drinking water that receives only disinfection prior to consumption. These objectives may be overly stringent because the turbidity levels in the river indicate that partial treatment (e.g., filtration) and disinfection are needed prior to consumption. The objective for body-contact recreation (e.g., swimming) was always met.
- Total dissolved nitrogen and phosphorus levels may have increased over time, which could have contributed to periphyton (attached algae) growth that has often exceeded its objective during the 1990's.
- Thompson River water was soft, but yet well buffered against acidic inputs.
- The true colour objective was always met.

RECOMMENDATIONS

Continue monitoring at this site, especially for indicators related to the major waste discharges from the upstream pulp mill near Kamloops. Key indicators to monitor in the future are: flow, fecal contamination indicators, dissolved organic carbon, AOX, chloride, true colour, conductivity, hardness, pH, total dissolved nitrogen and total dissolved phosphorus, periphyton, turbidity, and air and water temperature. Minimum detectable limits should be at least one-tenth of the water quality objectives or guidelines for all indicators. Continued monitoring of metals is a lower priority, but consideration should be given to measuring dissolved aluminum, and low-level cadmium, hexavalent and trivalent chromium, and silver to permit comparison to guidelines.

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INTRODUCTION

The Thompson River watershed, which has a drainage area in excess of 55,000 km^2, occupies a significant portion of southern British Columbia. It encompasses the North Thompson, the South Thompson, and the lower Thompson rivers, and is a very important tributary of the Fraser River. The Thompson (also referred to as the lower Thompson) River begins at Kamloops, at the confluence of the North Thompson and the South Thompson rivers, and flows for approximately 160 km before emptying into the Fraser River at Lytton. From the confluence of the North and South Thompson rivers, the Thompson flows almost immediately into Kamloops Lake, a body of water that reduces flow intensities and the sediment content in the river downstream (Regnier, 1997). At Savona, the river emerges from the lake and continues in a westerly direction until it reaches Ashcroft. Thereafter, it flows mostly to the south, past Spences Bridge, and ultimately into the Fraser River (Figure 1). The Thompson River is extremely important as a fish spawning and rearing habitat, and as a passageway for numerous salmonid species heading to the North and South Thompson rivers (Nordin & Holmes, 1992). The river also supports a significant amount of outdoor recreational activities, including fishing, camping, and river rafting. Other water uses for the Thompson River are irrigation, domestic water supply and industrial processes.

Water quality and flow data for the lower Thompson are acquired at a monitoring station at Spences Bridge, the furthest downstream monitoring station on the river.

The Weyerhaeuser pulp mill upstream from Kamloops Lake, the Kamloops sewage treatment plant, and various non-point sources, including forestry, agriculture, and urbanization, are the main human influences on the water quality of the Thompson River at Spences Bridge (Nordin & Holmes, 1992; Regnier, 1997). The pulp mill, which probably had the single largest influence, discharged a daily average of 182,000 m^3 of treated kraft mill effluent through diffusers into the river (Regnier, 1997). This discharge has been shown to alter levels of colour, conductivity, chloride, nitrate, calcium, sodium,

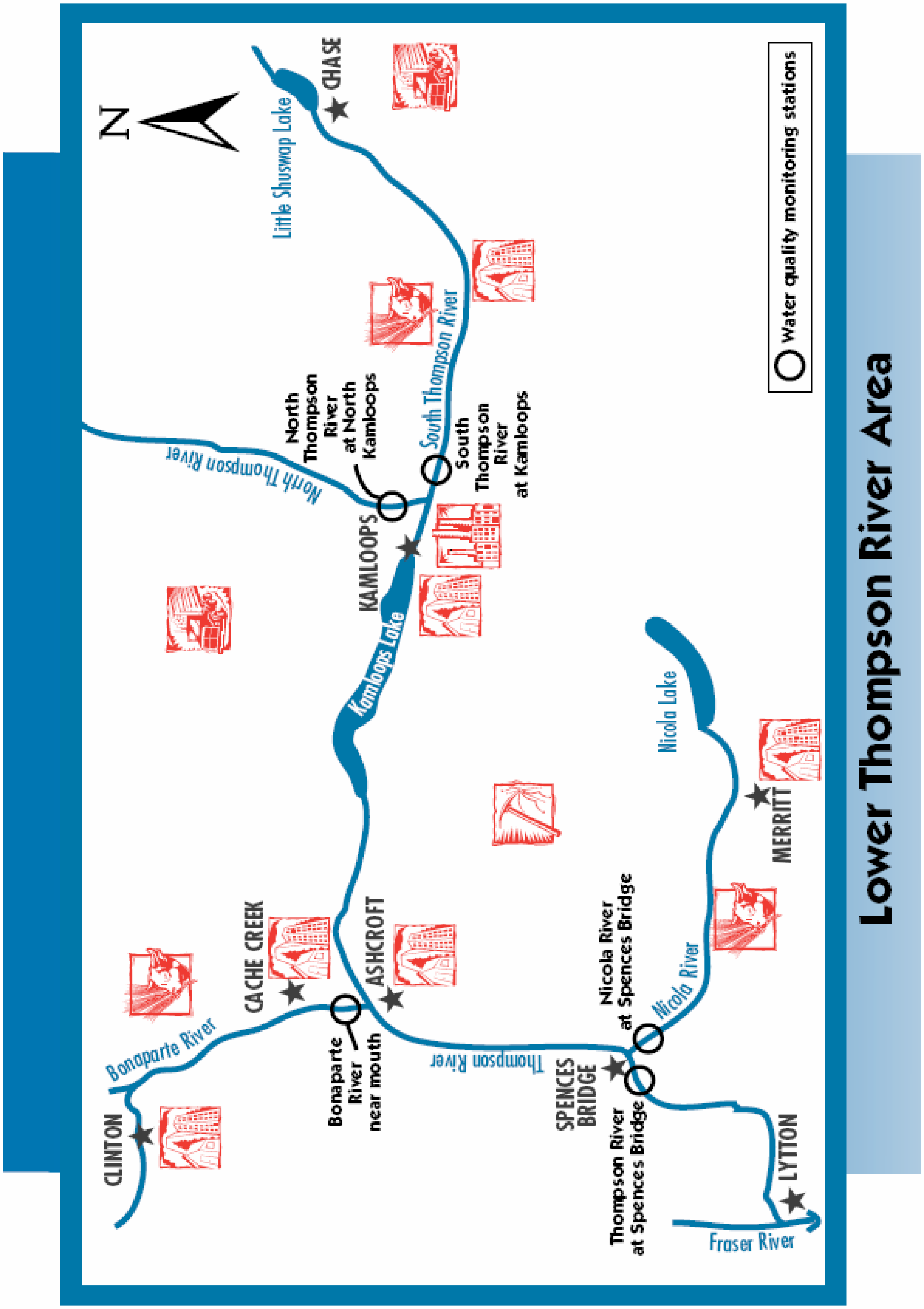

FIGURE 1. THOMPSON RIVER AT SPENCES BRIDGE

sulfate, and phosphorus within the river at downstream sites (Nordin & Holmes. 1992). Recently, the pulp mill has implemented numerous changes to reduce the environmental effects of the effluent. The most notable change has been the conversion from using elemental chlorine in the bleaching process to using chlorine dioxide. This conversion began in 1991 with 50% substitution, and was completed in late 1992/93 with 100% substitution (Regnier, 1997).

The flow of the Thompson River near Spences Bridge (Figure 2) is taken from Environment Canada site BC08LF051, which has a drainage area of 54,900 km^2. This is also the same location as both the federal and provincial water quality sampling stations. Environment Canada has monitored the water quality at this station biweekly since 1985. The federal data are stored on the federal data base, ENVIRODAT, under station number BC08LF0001. The B.C. Ministry of Environment, Lands and Parks (MELP) also collected data from this site approximately 26 times a year, beginning in 1987. The provincial data are stored on the province's Environmental Monitoring System (EMS) data base under site number E206586. This report assesses up to 17 years of data between 1985 and 2000. The water quality data are plotted in alphabetical order in Figures 3 to 49. Other water quality stations within the Thompson River watershed include: the North Thompson at North Kamloops (Brewer and Webber, 1997a), the South Thompson at Kamloops (Lilley *et al*. 2000), the Bonaparte River near mouth (Brewer and Webber, 1997b), Salmon River at Highway #1 Bridge (Lilley and Webber, 2000) and the Nicola River at Spences Bridge.

WATER QUALITY ASSESSMENT

The state of the water quality was assessed by comparing the values to the water quality objectives for the Thompson River (Nordin and Holmes, 1992) and to B.C.'s approved and working guidelines for water quality (MELP 2000a, 2000b), 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 discussion of the water quality indicators in alphabetical order.

The following water quality indicators were not discussed as they met all water quality guidelines and showed no clearly visible trends: total barium, total beryllium, dissolved fluoride, total lithium, magnesium, total molybdenum, potassium, total selenium, silica, total strontium, and total vanadium.

Adsorbable organo-halide (AOX) concentrations ranged from below detection limits (<0.01 mg/L) to a maximum of 0.04 mg/L in the Thompson River at Spences Bridge (Figure 3). The water quality guideline for AOX for aquatic life is no increase over background levels at a 95% confidence limit. Concentrations of AOX were measured less frequently at both the North and South Thompson monitoring sites, and sampling dates seldom corresponded to those for the Thompson River at Spences Bridge, making a direct comparison of AOX values difficult. However, concentrations of AOX in both the North and South Thompson were almost invariably below detection (<0.01 mg/L), with one value of 0.011 mg/L reported for the South Thompson River on March 14, 2001. In the ten instances where samples were collected at both the North and South Thompson sites as well as the Spences Bridge site, the maximum increase in AOX concentrations at Spences Bridge was 0.01 mg/L. AOX concentrations may have declined during 1992-2000, but the data are sparse and all within four times the detection limit, and thus must be interpreted with caution. Concentrations of chlorinated phenols and dioxins and furans (for which AOX is a surrogate indicator) were below detection limits (ranging from < 0.000001 mg/L to < 0.001 mg/L) for the entire period of record (see Table 1). In addition, dioxin and furan levels in Mountain Whitefish declined to meet objective levels during 1988-95 (Ministry of Environment, Lands and Parks and Environment Canada, 2000).

Total alkalinity concentrations fluctuated seasonally, generally ranging between 27.5 and 53.3 mg/L (Figure 4). Concentrations were highest in the fall and winter months, and lowest in the spring and early summer. This pattern is as would be expected, with spring snow melt resulting in the dilution of alkalinity. The maximum value, 64.3 mg/L measured on June 25, 1989, appears to be an outlier, as it was approximately twice as high as values measured both two weeks before and two weeks after. There appears to be a gradual trend towards increasing values over time at this site. **Dissolved and extractable calcium** concentrations followed similar trends, with increasing concentrations in winter months and decreasing concentrations in spring/early summer (Figure 11). Concentrations generally ranged between 10 and 18 mg/L. The range of both alkalinity and calcium concentrations suggest that the Thompson River at Spences Bridge is well buffered and has a low sensitivity to acid inputs year-round (the threshold for this rating is considered to be about 20 mg/L for alkalinity, and 8 mg/L for calcium).

Total aluminum concentrations ranged from 0.02 to 2.5 mg/L for 233 samples collected between 1991 and 2000 (Figure 5). Sixty-three of the 269 samples had concentrations exceeding the drinking water guideline (a maximum of 0.2 mg/L **<u>dissolved</u>** aluminum), and 169 samples exceeded the aquatic guidelines (0.05 mg/L **<u>dissolved</u>** aluminum). The total aluminum guideline of 5 mg/L for wildlife, livestock, and irrigation was not exceeded. As total (and not dissolved) aluminum was measured for these samples, the data cannot be accurately compared with the drinking water or aquatic guidelines (both stated in terms of dissolved aluminum concentrations). There was a close correlation between elevated total aluminum concentrations and increased turbidity levels (see Figure 5), suggesting that the majority of aluminum was present in the suspended form and therefore not likely bioavailable, and would be removed by the treatment needed prior to drinking. There was no apparent change over time. It would be desirable to measure dissolved aluminum to permit comparison to drinking water and aquatic life guidelines.

In general, **total arsenic** concentrations were well below aquatic life guideline levels of 0.005 mg/L, ranging from below detectable limits (<0.0001 mg/L) to 0.0013 mg/L (Figure 6). One high value (0.0126 mg/L) exceeded this guideline, on February 28, 1994. The reason for this exceedance is uncertain, as turbidity levels were low (1.05 NTU). There was no apparent change over time.

Total cadmium concentrations were measured 345 times between 1986 and 2000 with a detection limit of 0.0001 mg/L (Figure 10). The maximum recorded value was 0.0011 mg/L. The minimum detection limit used (0.0001 mg/L) exceeded the aquatic life guideline for total cadmium of 0.00001 – 0.00003 mg/L at a hardness of less than 90 mg/L (typical for this reach of the Thompson River) by a factor of 3-10. Therefore, although 233 of the 345 samples had concentrations below detectable limits, the remaining 112 samples exceeded the guidelines. Maximum values collected between 1986 and 1991 are suspect due to preservative vial contamination. Peak values measured after this period coincided with elevated turbidity levels, suggesting that the cadmium was associated with particulate matter and probably not bioavailable. In the future, an analytical method should be used with a detection limit at least a factor of 10 lower than the guideline level (a maximum of 0.000001 mg/L) to allow the data to be compared to the guideline. There was no apparent change over time.

Dissolved organic carbon (DOC) concentrations ranged from 0.5 to 4.8 mg/L for 76 values collected between 1997 and 2000 (Figure 12). Five values (6.6%) exceeded the drinking water guideline of 4 mg/L for water that undergoes chlorination prior to consumption. All of these exceedances occurred by early 1998, and although the period of record is too short to make conclusions regarding DOC trends, it appears that concentrations have decreased slightly between 1997 and 2000.

Dissolved chloride concentrations were measured 381 times between 1984 and 2000, with values ranging from below detection (<0.1 mg/L) to 5.2 mg/L (Figure 13). There appears to be a strong trend towards decreasing concentrations of chloride at this site, likely due to the elimination of chlorine in the bleaching process by the Weyerhaeuser pulp mill. Regardless, all values are well below the 250 mg/L aesthetic guideline for drinking water, as well as the irrigation guideline of 100-700 mg/L (depending on the crop).

Total chromium values ranged from 0.0002 mg/L to 0.343 mg/L for the 233 samples analyzed for this metal (Figure 14). Guidelines for chromium are stated in terms of the trivalent and hexavalent forms. The aquatic life guidelines are a maximum of 0.001 mg/L for hexavalent chromium and 0.009 mg/L for trivalent chromium, and the irrigation guidelines are a maximum of 0.005 mg/L trivalent chromium and 0.008 mg/L hexavalent chromium. Total chromium concentrations seldom exceeded the 0.005 – 0.009 mg/L guidelines (1% of all samples) and occasionally exceeded the 0.001 mg/L guideline (15% of all values). There was a fairly good correlation between total chromium concentrations and turbidity values, especially after about 1993 (see Figure 14), suggesting that some of the chromium is associated with particulate matter. However, other values that exceeded the aquatic guideline for hexavalent chromium did so at a time when turbidity levels were not elevated. Therefore, chromium may be a concern at this site, depending on the form of chromium present. Measurements of the trivalent and hexavalent forms of chromium with detection limits of 0.0001 mg/L or lower should be made when the analytical methods become available. There was no apparent change during 1994-2000, ignoring the somewhat higher anomalous values before 1994.

Total cobalt concentrations ranged between 0.0001 and 0.0025 mg/L for 256 values collected between 1990 and 2000 (Figure 15). A total of nine values (3.5%) exceeded the guideline for aquatic life (0.0009 mg/L), but all occurred at the same time as turbidity peaks (see Figure 15), suggesting that the cobalt was in particulate form and therefore probably not bioavailable. There was no apparent change in cobalt levels over time.

Fecal coliforms concentrations were measured 54 times between 1989 and 2000, with values ranging from 1 CFU/100 mL to 120 CFU/100mL (Figure 16). The 90^{th} percentile of these 54 values was 13 CFU/100 mL, which exceeded the 10/100 mL objective for fecal coliforms in the Thompson River at Spences Bridge. Both *E. coli* (Figure 20) and enterococci (Figure 21) were measured occasionally as well (20 times between 1993 and 1999, and 5 times in the summer of 1992, respectively). The 90^{th} percentiles for *E. coli* and enterococci concentrations were 5 CFU/100 mL and 7.6 CFU/100 mL, respectively. The primary-contact recreation objectives and guidelines for fecal coliforms and E. coli

(200/100 mL) and enterococci (20/100 mL) were always met. While the 90th percentile for *E. coli* was below the drinking water guideline for water undergoing disinfection (10/100 mL), the 90th percentile for enterococci exceeded the 3/100 mL drinking water guideline. However, an accurate comparison of these data with the guidelines requires a minimum of 5 samples in a 30-day period, and ideally 10 samples within a 30-day period, a condition not met by these data. In addition, there are too few data over too short of a period to make a useful assessment in terms of possible trends. The water quality objectives proposed for these indicators may be overly stringent, as turbidity levels indicate that partial treatment (such as filtration) is necessary prior to consumption. If this is the case, objectives would be increased to 100/100 mL for both fecal coliforms and *E. coli*, and to 25/100 mL for enterococci.

True colour concentrations ranged from 5 to 15 TCU for 92 values measured between 1995 and 2000 (Figure 12). The water quality objective (based on the aesthetic guideline for recreation and drinking water of 15 TCU) was therefore not exceeded by any of the samples. The data record is too sparse and short to comment on trends over time.

Total copper concentrations ranged from 0.0002 mg/L to 0.0106 mg/L for 233 samples analyzed between 1991 and 2000 (Figure 19). Aquatic life guidelines for total copper are hardness-dependent: at hardness levels typical for the Thompson River at Spences Bridge, these would typically be a maximum of 0.005 mg/L, and a 30-day average of about 0.002 mg/L. By calculating maximum and average guidelines for each of the 233 samples based on their concurrent hardness concentrations, it was determined that four values (1.7% of all samples) exceeded their appropriate maximum guideline, while 31 samples (13.3%) exceeded the 30-day average guideline. This comparison is used only as an indication of potential exceedances, because the calculation of a 30-day average requires a minimum of five samples collected within a 30-day period (a criterion not met in this instance). Except for a few elevated total copper concentrations measured between 1991 and 1992, there was a good correlation between elevated copper and elevated turbidity levels, suggesting that copper was often associated with particulate matter and therefore not likely biologically available. There was no apparent change over time.

Hardness concentrations were typically low (between about 30 and 60 mg/L), indicating that the water was quite soft, and well within acceptable limits for drinking water (water is considered to be a poor source of drinking water when hardness exceeds 200 mg/L) (Figure 23). Seasonal fluctuations, much like those seen for alkalinity and total calcium, were also observed for hardness concentrations, as would be expected. There may have been a slight increasing trend over time, but the levels are too low to be of concern.

Total iron concentrations exceeded the 0.3 mg/L drinking water (aesthetics) and aquatic life guideline on 91 occasions (25% of the 368 samples collected) (Figure 24). In addition, the irrigation guideline (5 mg/L) was exceeded on one occasion. A strong correlation between elevated total iron concentrations and elevated turbidity levels suggests that much of the iron was present in the particulate form, which limits its bioavailability (and thus also limits its toxicity). Drinking water used during the spring freshet (or during other periods of elevated turbidity) would require particulate removal, and this would likely decrease iron concentrations to below the aesthetic objective. There was no apparent change over time.

Total lead concentrations exceeded the drinking water guideline (0.01 mg/L) on one occasion (June 20, 1994), with an extremely high concentration of 0.985 mg/L (Figure 25). As the next-highest concentration of the 233 samples collected at this site was only 0.0024 mg/L, it appears likely that this value is an error. All other concentrations were well below the 0.01 mg/L guideline for drinking water, and the 0.004 mg/L average guideline for aquatic life. There was no change over time.

Dissolved/extractable magnesium concentrations were well below aesthetic drinking water guidelines (100 mg/L), with concentrations ranging from 1.2 to 5.09 mg/L between 1984 and 2000 (Figure 27). However, it appears that there may have been a slight increase in magnesium concentrations over time at this site, which would have contributed to the increasing trend in hardness.

Total manganese concentrations ranged from 0.002 mg/L to 0.139 mg/L for 368 samples collected between 1985 and 2000 (Figure 28). Six samples (1.6%) exceeded the aesthetic drinking water guideline of 0.05 mg/L. The strong correlation between manganese and elevated turbidity levels indicates that the majority of the total manganese was in the particulate form, not likely bioavailable, and would be removed by the treatment needed to remove turbidity prior to drinking. There was no apparent change over time.

The aquatic life guideline of 0.025 mg/L for **total nickel** was exceeded by one of 285 samples, with a concentration of 0.0398 mg/L (Figure 30). The next-highest concentration was 0.0077 mg/L, well below the guideline level. Therefore, it appears that the maximum value may have been an outlier, but regardless, it does not appear that nickel is a significant environmental concern at this site, and there was no change over time.

Nitrogen concentrations were measured both in terms of **nitrate + nitrite** (Figure 31), as well as **total dissolved nitrogen** (Figure 32). Concentrations of nitrate + nitrite ranged from 0.002 to 0.205 mg/L, while concentrations of dissolved nitrogen ranged from 0.01 to 0.38 mg/L. All values were well below the drinking water guideline of 10 mg/L for nitrate + nitrite, but there may have been an increasing trend in total dissolved nitrogen over time.

Dissolved oxygen concentrations were measured 16 times between 1998 and 1999, with values ranging from 10 mg/L to 14.6 mg/L (Figure 33). The majority of samples were collected during the winter months, when water temperatures are cooler and water that is not under ice cover is more likely to be highly oxygenated. All values met the guidelines for aquatic life.

pH values were invariably between the upper and lower guideline limits for drinking water aesthetics (6.5-8.5) and aquatic life (6.5-9) between 1989 and 2000 (Figure 34). There was no apparent change in pH levels over time.

Phosphorus concentrations were measured in terms of the **total phosphorus** (Figure 37), **dissolved phosphorus** (Figure 36) and **ortho-phosphorus** (Figure 35) fractions. Total phosphorus concentrations ranged from < 0.002 mg/L to 0.247 mg/L, dissolved phosphorus levels ranged from < 0.002 to 0.023 mg/L, and ortho-phosphorus levels ranged from <0.001 to 0.024 mg/L. There is no guideline for phosphorus concentrations in moving water, but both total phosphorus and total dissolved phosphorus concentrations may have increased slightly over time. This trend should be viewed with caution, since the majority of the values for both indicators was less than ten times the detection limits and thus in the semi-quantitative zone of measurement. This possible increase in phosphorus concentrations may have had an impact on periphyton concentrations, which frequently exceeded the objective during the 1990s (Ministry of Environment, Lands and Parks, 1996 and Ministry of Water, Land and Air Protection, 2001). (P.S. It would be worthwhile to assemble the long-term time series of periphyton chlorophyll a measurements for this station – I will see what I can find.)

Filterable residue (*i.e.*, dissolved solids) concentrations ranged from 43 mg/L to 216 mg/L during 1985-95, although the majority of the values lay between 50 and 100 mg/L (Figure 39). All values were well below the aesthetic drinking water and irrigation guideline of 500 mg/L. As specific conductivity is a good surrogate for filterable residue, and is less expensive and more precise to measure, filterable residue has not been measured since 1995. There was no apparent change over time, as was the case for conductivity.

Residue, non-filterable (*i.e.* suspended solids) was measured 258 times between 1986 and 1998, with values ranging from 1 mg/L to 138 mg/L (Figure 40). Only three samples had non-filterable residue concentrations over 40 mg/L. Twelve values exceeded the general fisheries guideline of 25 mg/L (Newcombe, 1986), generally between March and

June (corresponding with the spring freshet). Turbidity values were often not measured on the same day that non-filterable residue samples were collected, but when both were measured there was a good correlation between them (as would be expected). **Turbidity** values ranged from 0.09 NTU to 41 NTU for 379 samples collected between 1984 and 2000 (Figure 46). These values are relatively low for a river, because of the settling of suspended sediment in Kamloops Lake. Nevertheless, approximately 50% of samples exceeded the health guideline for drinking water (1 NTU), while 9% of samples exceeded the aesthetic drinking water guideline (5 NTU). This indicates that partial treatment (e.g., filtration) is necessary before the Thompson River can be used as a drinking water supply. It appears that turbidity levels may have increased over time.

Sodium concentrations appear to have decreased between 1984 and 2000 (Figure 42), corresponding to the similar trend noted for chloride (Figure 13). This decline may be also be related to improvements in the operation of the Weyerhaeuser pulp and paper mill upstream from Kamloops Lake. However, sodium levels were well below guideline levels, and are therefore not a cause for concern at this site.

Total silver concentrations were measured 124 times between 1996 and 2000 (Figure 43). Only one value, 0.0005 mg/L, was reported above the detection limit (0.0001 mg/L). All other values were at or below the detectable limit. The maximum aquatic life guideline is 0.0001 mg/L, and was therefore exceeded by the single measurable value. However, the concentration was less than 10 times the detectable limits and therefore probably below the limits of quantification, so it should be interpreted with caution. An analytical method with a detection limit of not greater than 0.000005 mg/L should be used in the future to accurately assess total silver concentrations with respect to the guidelines.

Water temperature was measured 487 times between 1984 and 2000, ranging from about 0 degrees Celsius to 20 degrees Celsius (Figure 45). During the summer, the aesthetic guideline for drinking water of a maximum of 15 degrees Celsius was often exceeded, but the water was warm enough for swimming. The maximum summer temperatures also exceeded the 19 degrees Celsius guideline for salmonids on seven occasions.

Total zinc concentrations ranged from <0.0002 mg/L to a maximum of 0.0357 mg/L for 233 samples collected between 1991 and 2000 (Figure 49). Both the maximum and average guidelines for aquatic life are dependent on hardness. Because hardness concentrations were consistently below 90 mg/L, the maximum guideline for total zinc was 0.033 mg/L for all samples, and the average guideline was always 0.0075 mg/L. Only one value (0.4% of samples) exceeded the maximum guideline, and seven values (3%) exceeded the average guideline. These exceedances were concurrent with increases in turbidity on about half of the occasions (see Figure 49). On these occasions, it is likely that the zinc was present in particulate form and was not likely bioavailable. On other occasions, it is possible that the elevated total zinc levels may have been a cause for concern. However, the comparison of data with the average guideline is not entirely accurate, in that the calculation of an average value requires a minimum of five samples to be collected in a 30-day period, a condition which was not met by these data. There was no apparent change over time.

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Figure 2. Hydrometric Record for Thompson River near Spences Bridge (WSC Site BC08LF051), 1984 - 2000

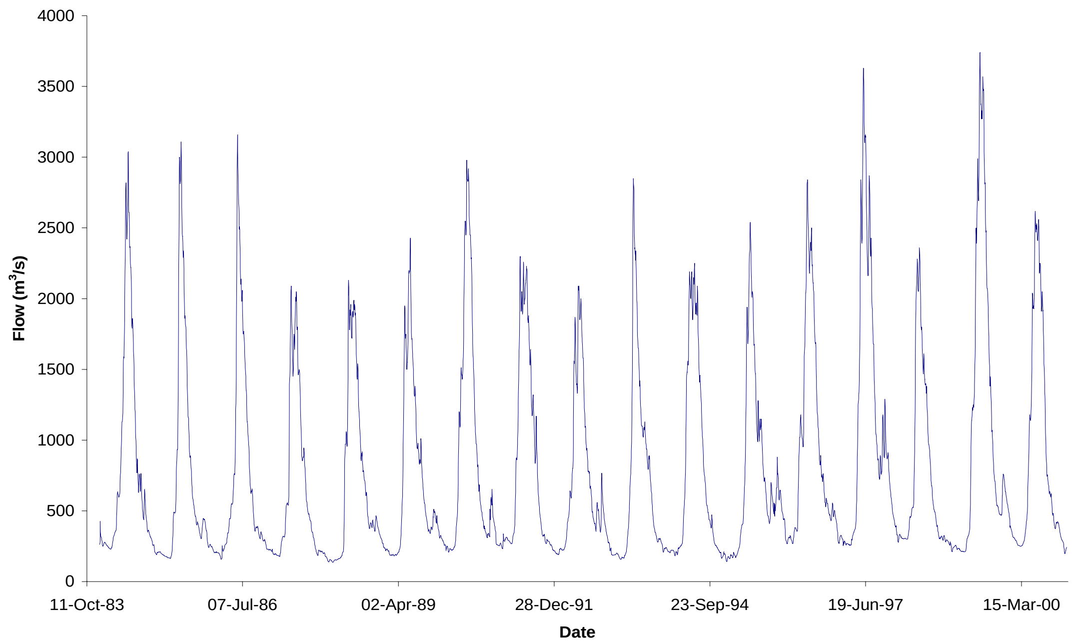

Figure 3. Thompson River at Spences Bridge - Adsorbable Organic Halides

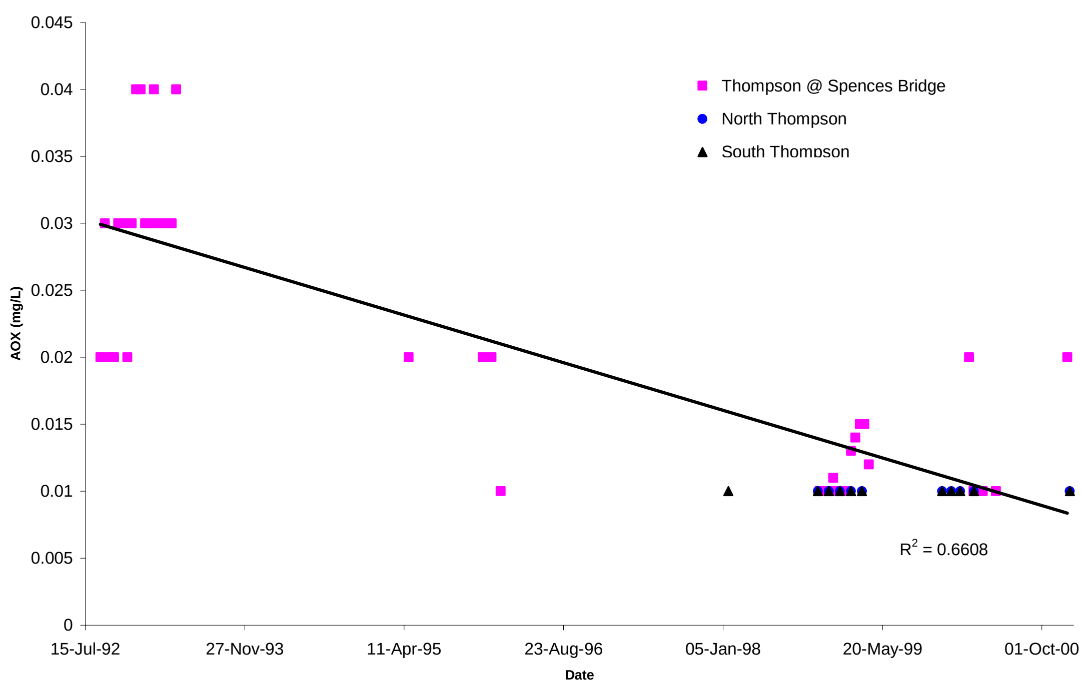

Figure 4. Thompson River at Spences Bridge - Alkalinity, Total 4.5

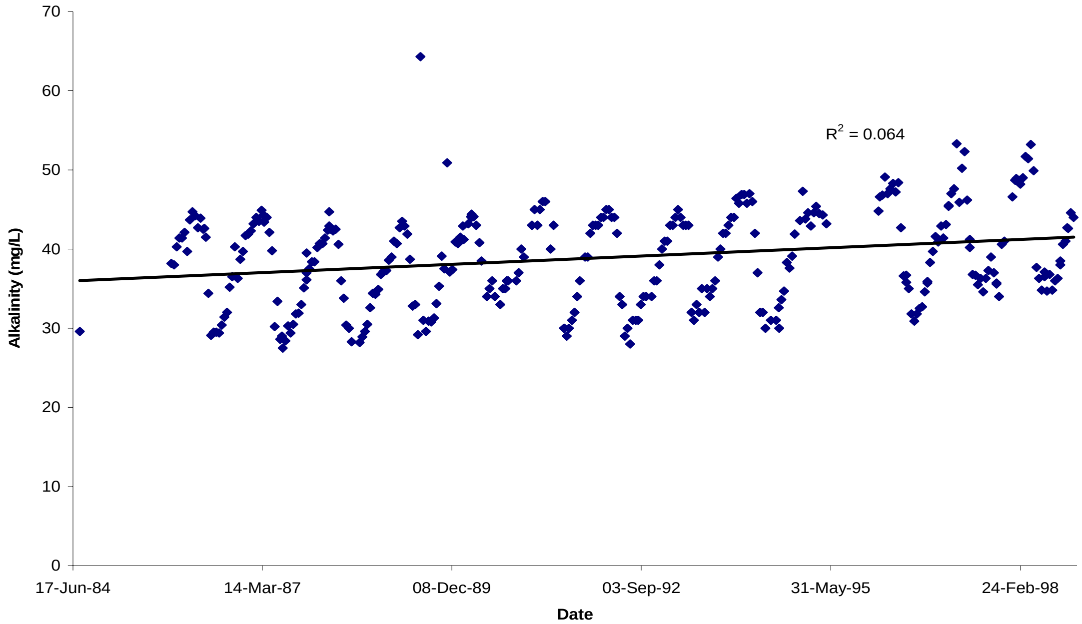

Figure 5. Thompson River at Spences Bridge - Aluminum, Total, and Turbidity

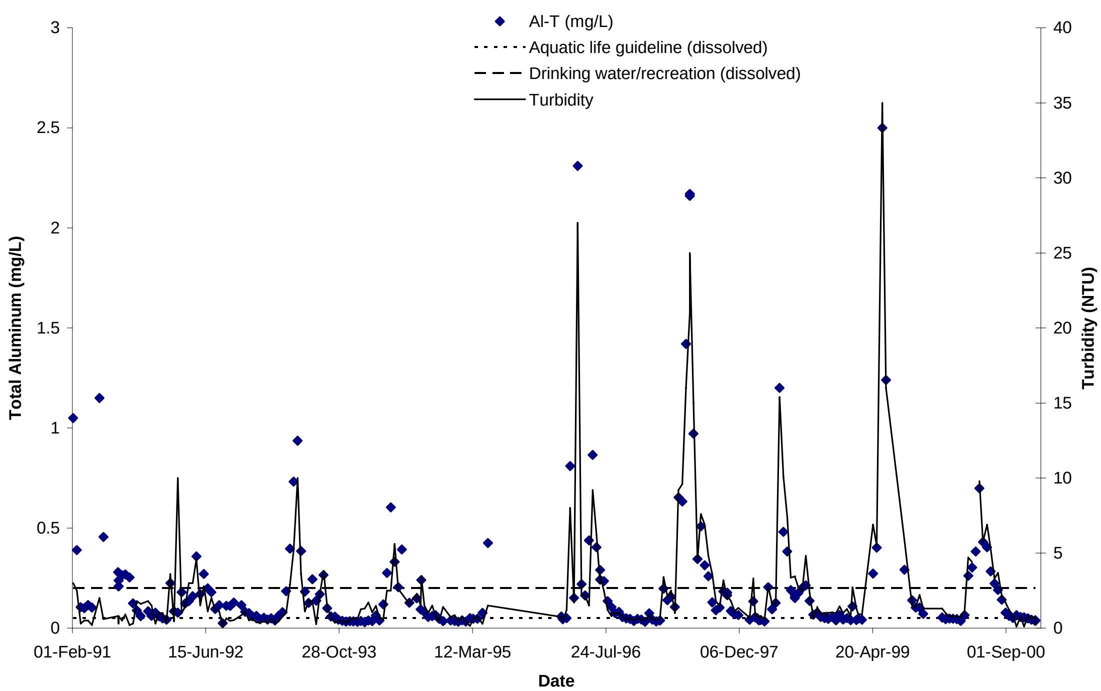

Figure 6. Thompson River at Spences Bridge - Arsenic, Total

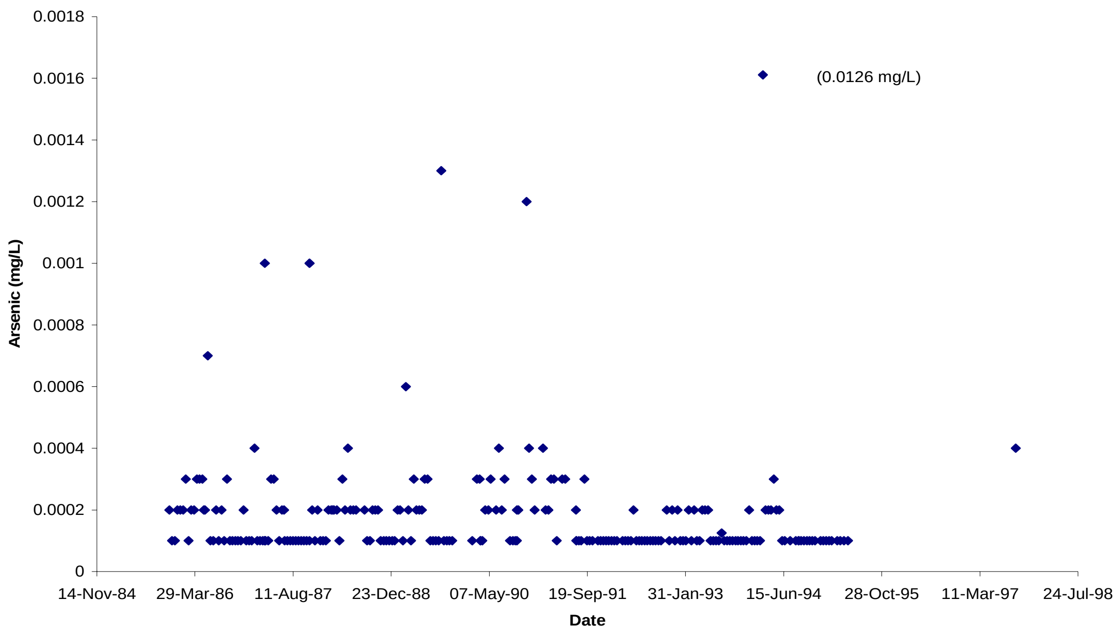

Figure 7. Thompson River at Spences Bridge - Barium, Total

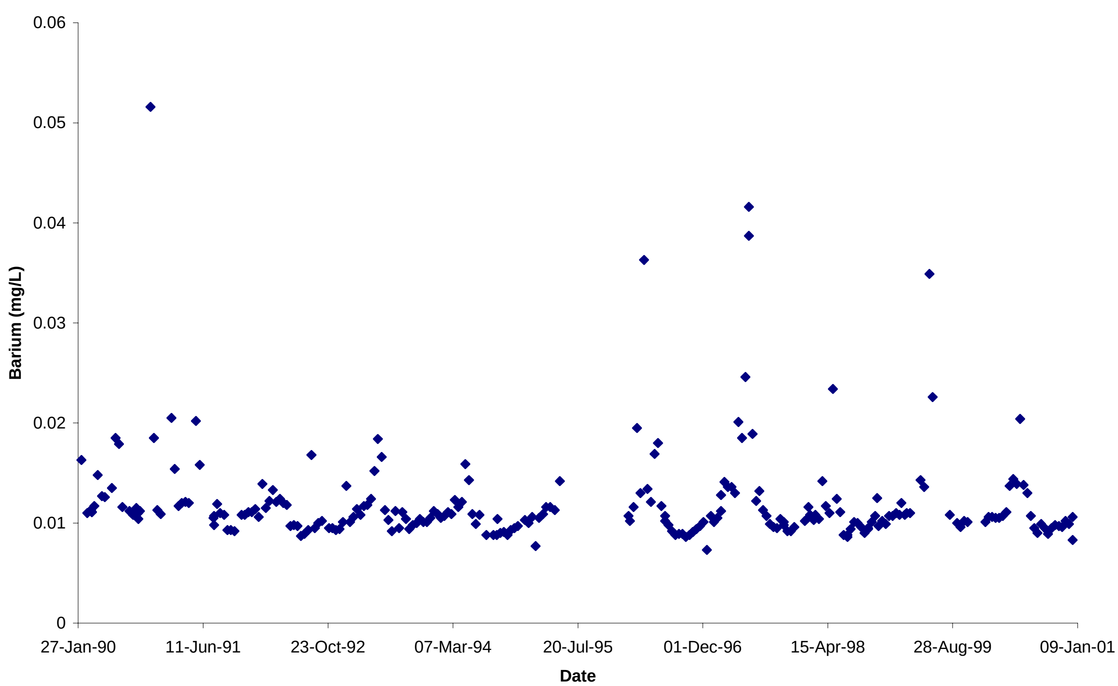

Figure 8. Thompson River at Spences Bridge - Beryllium, Total

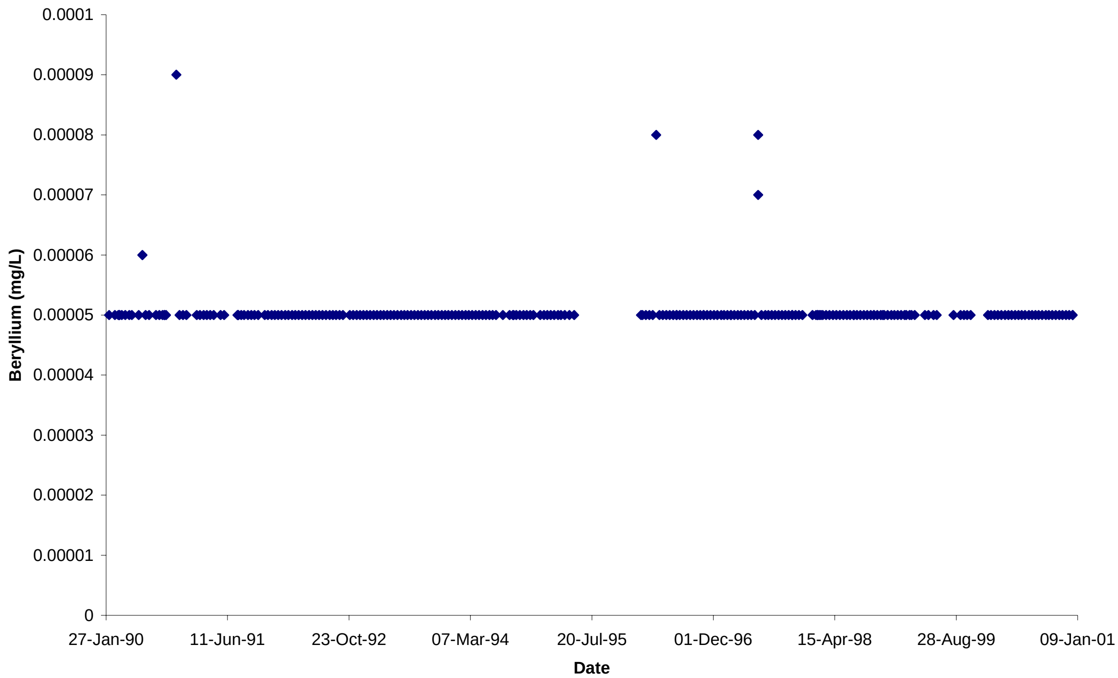

Figure 9. Thompson River at Spences Bridge - Bromide, Total

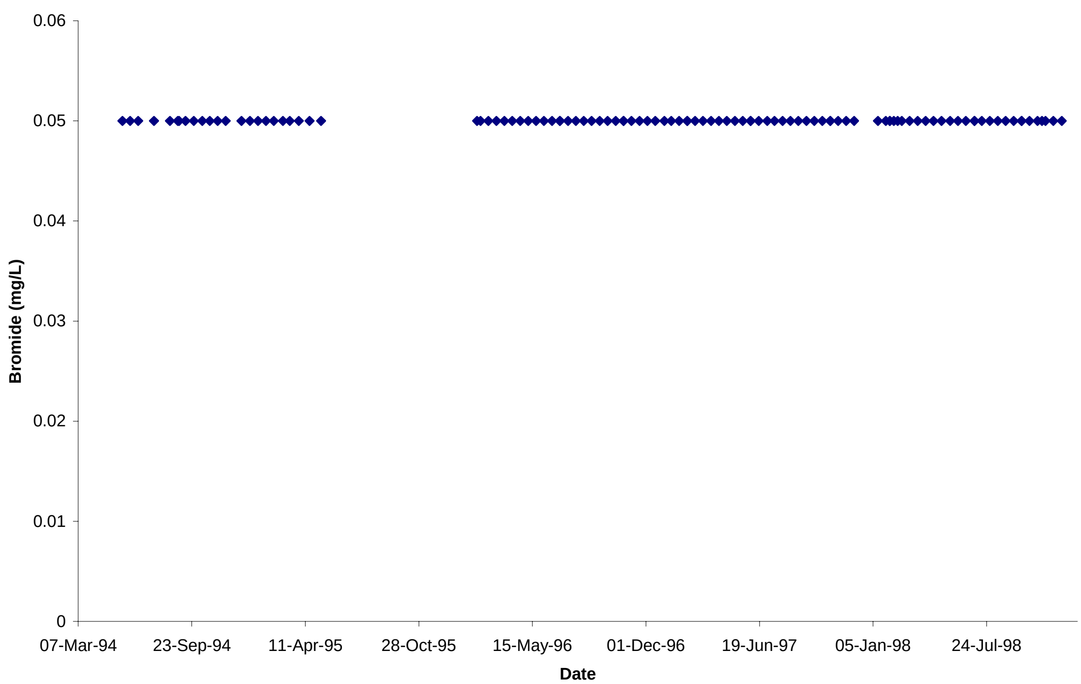

Figure 10. Thompson River at Spences Bridge - Cadmium, Total

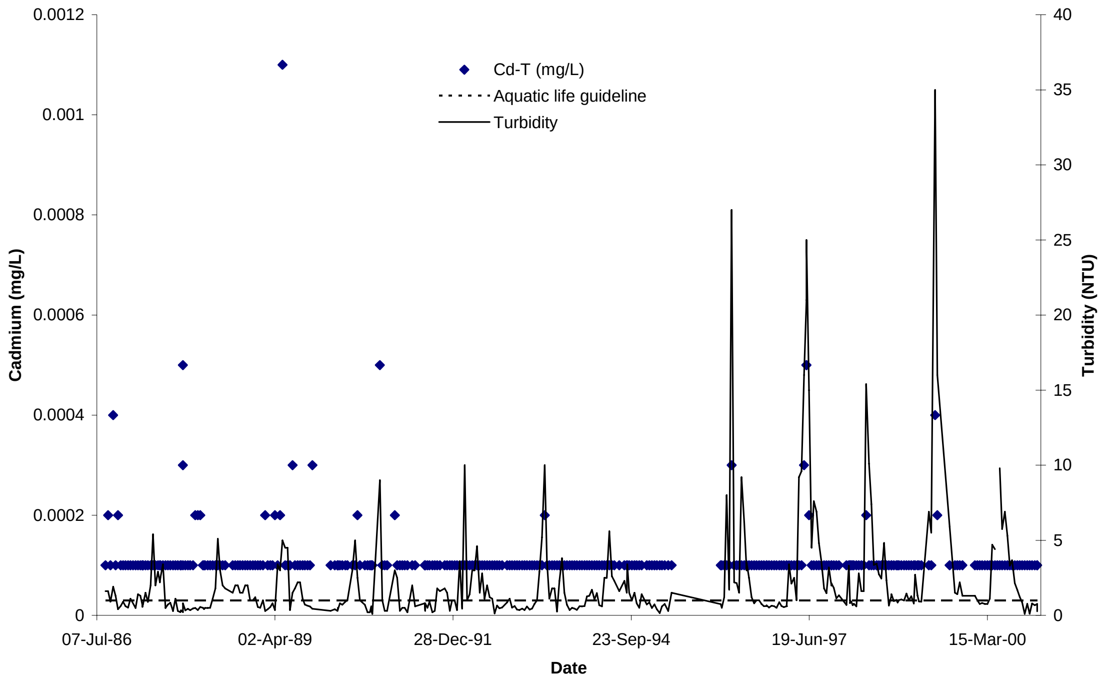

Figure 11. Thompson River at Spences Bridge - Calcium, Dissolved and Extractable

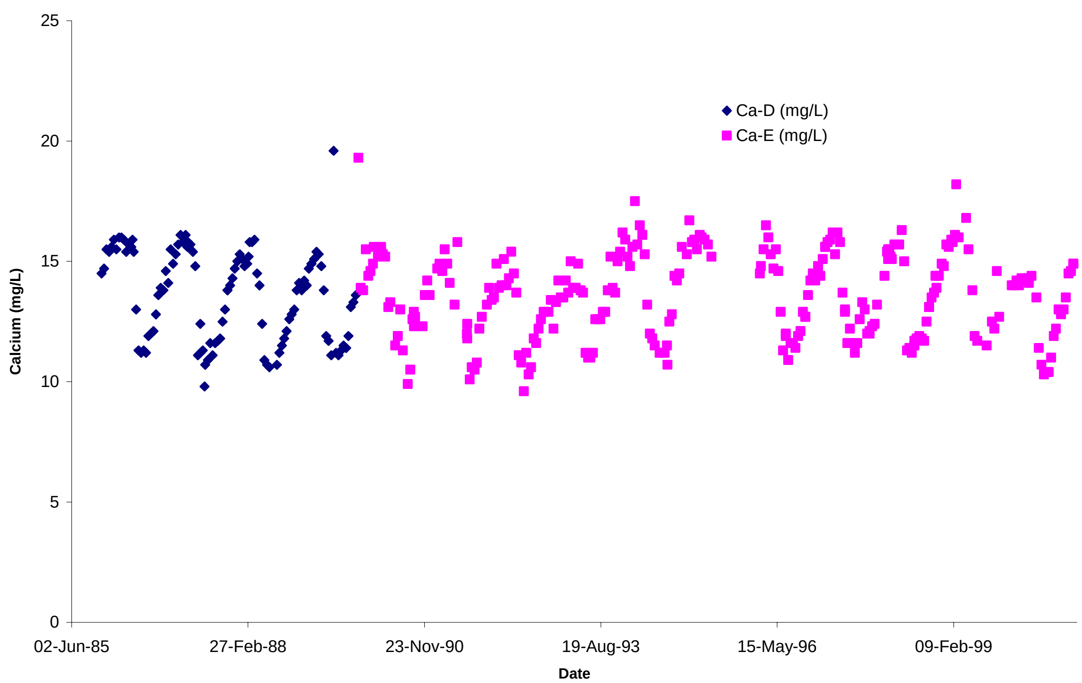

Figure 12. Thompson River at Spences Bridge - Carbon, Dissolved Organic

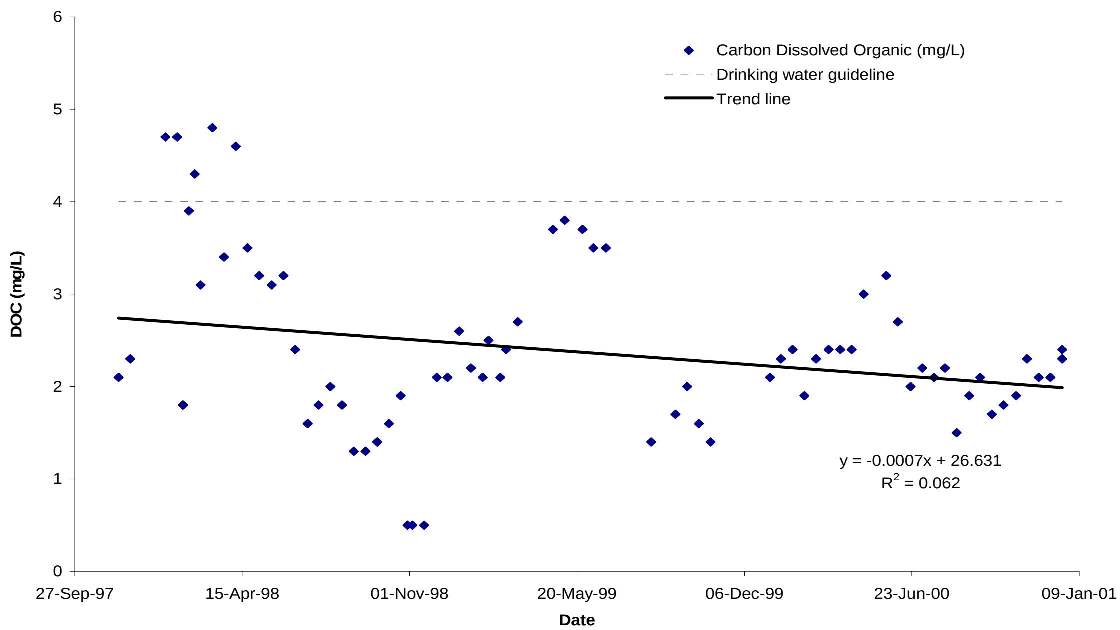

Figure 13. Thompson River at Spences Bridge - Chloride, Dissolved

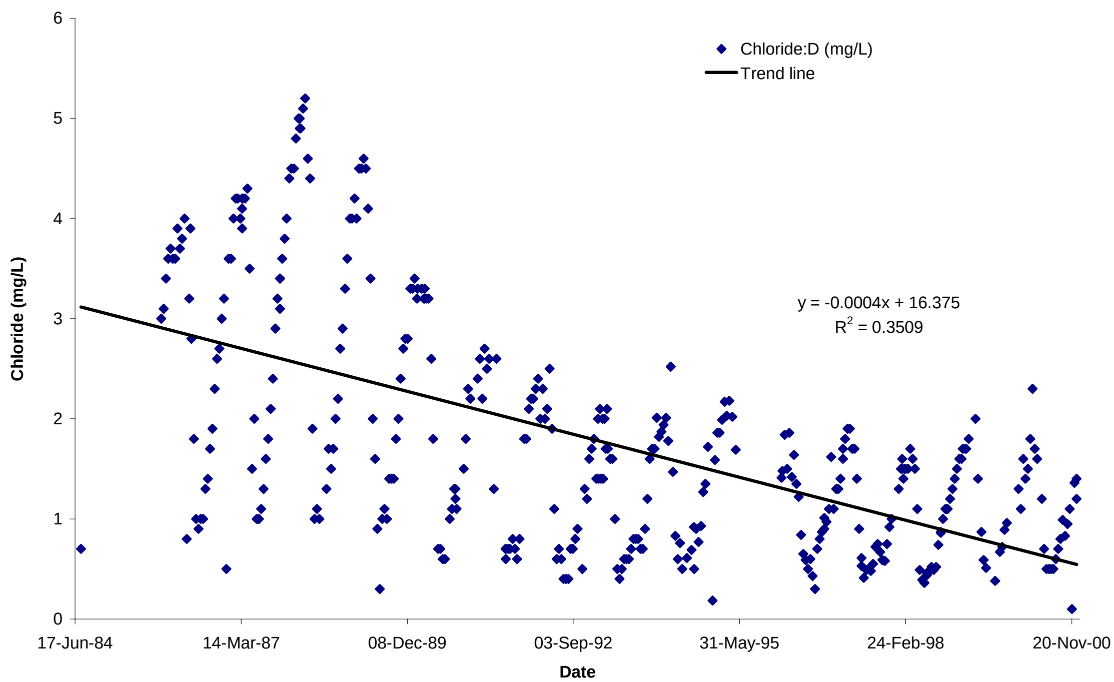

Figure 14. Thompson River at Spences Bridge - Chlorophyll *a*

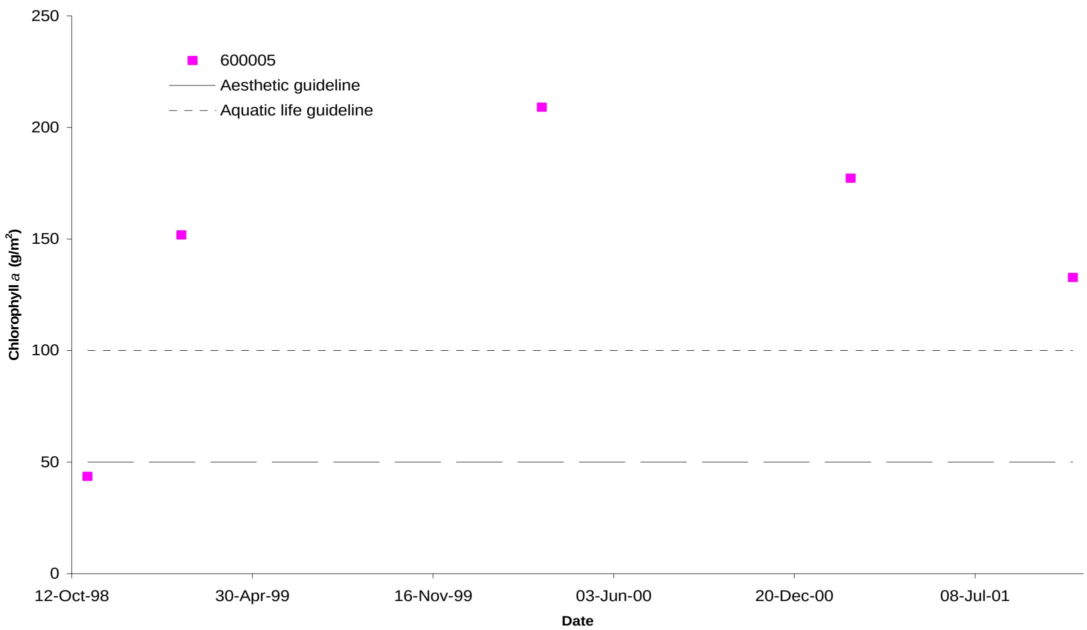

Figure 15. Thompson River at Spences Bridge - Chromium, Total, and Turbidity

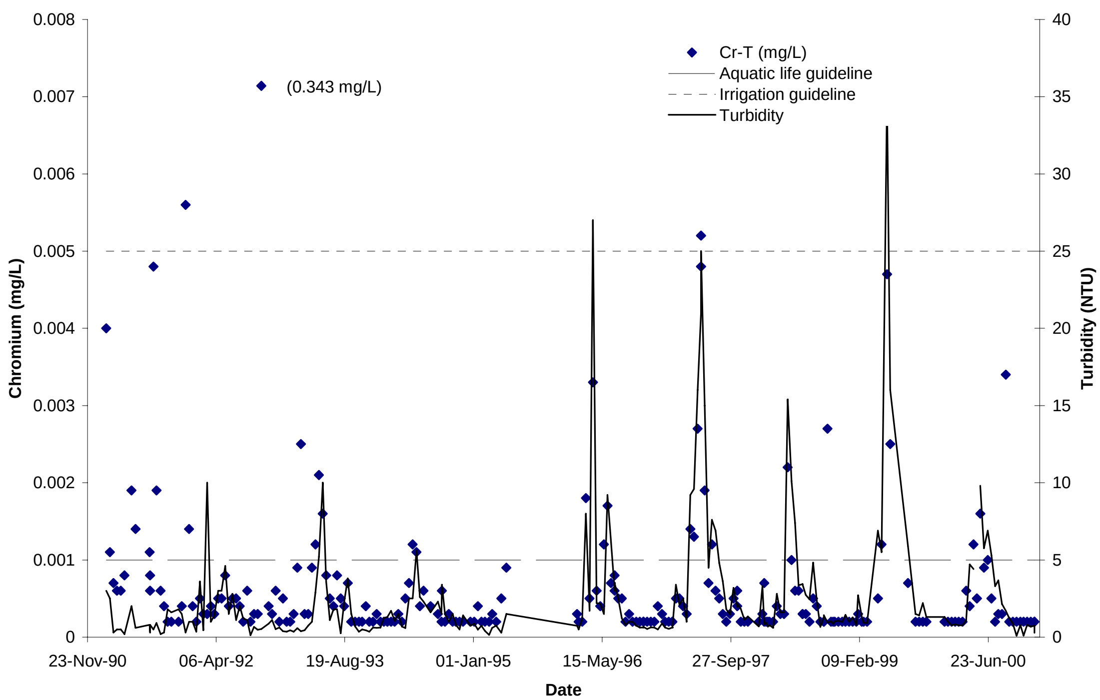

Figure 16. Thompson River at Spences Bridge - Cobalt, Total, and Turbidity

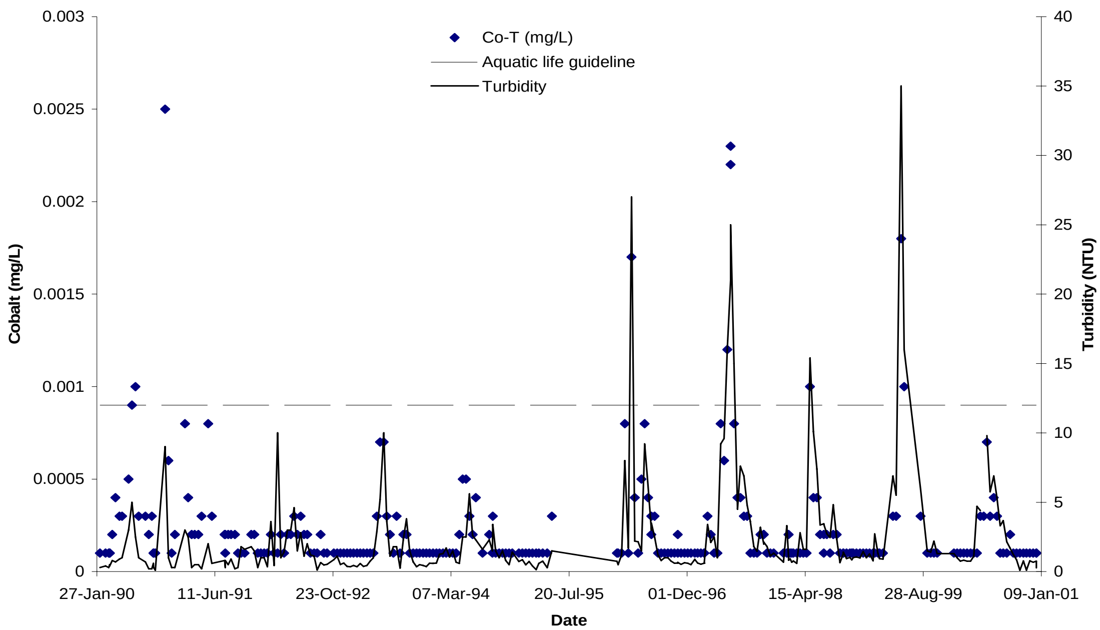

Figure 17. Thompson River at Spences Bridge - Bacteriology

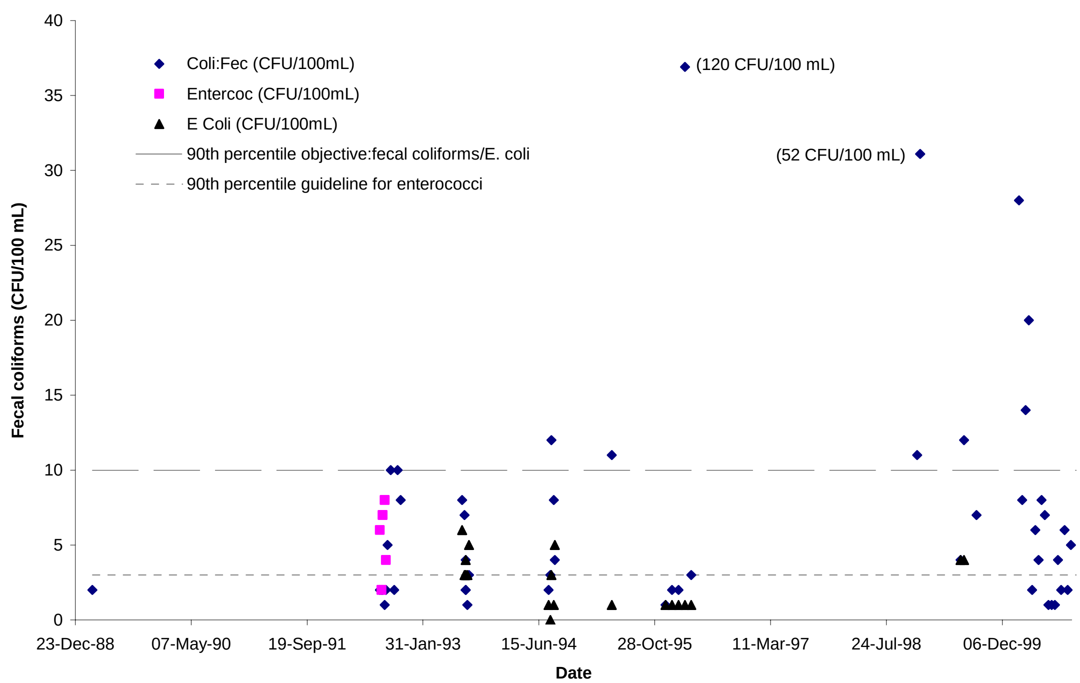

Figure 18. Thompson River at Spences Bridge - Colour, True

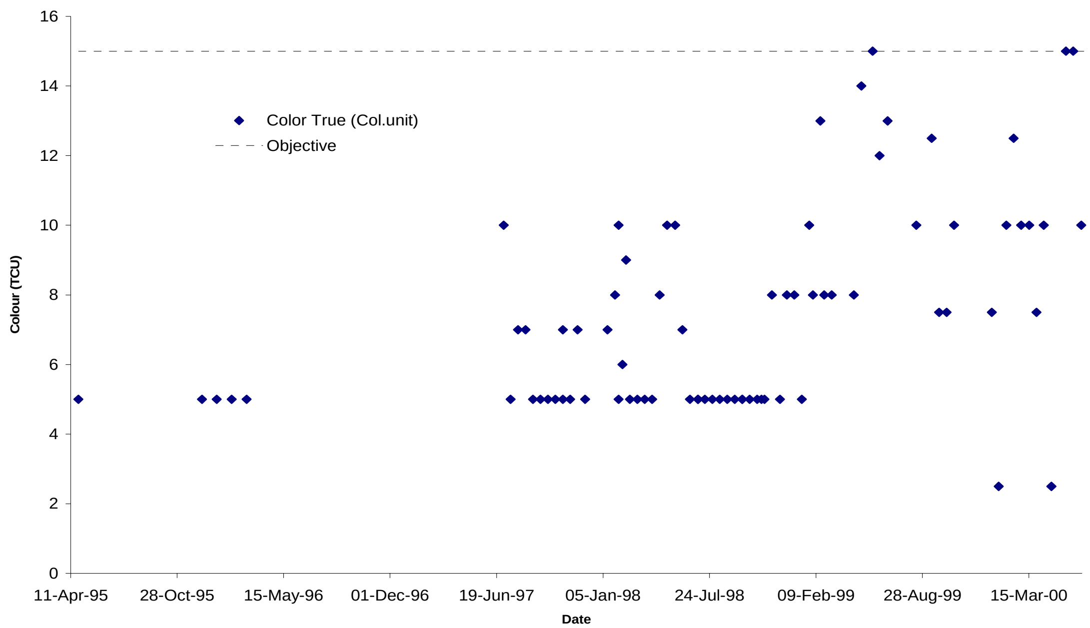

Figure 19. Thompson River at Spences Bridge - Conductivity, Specific

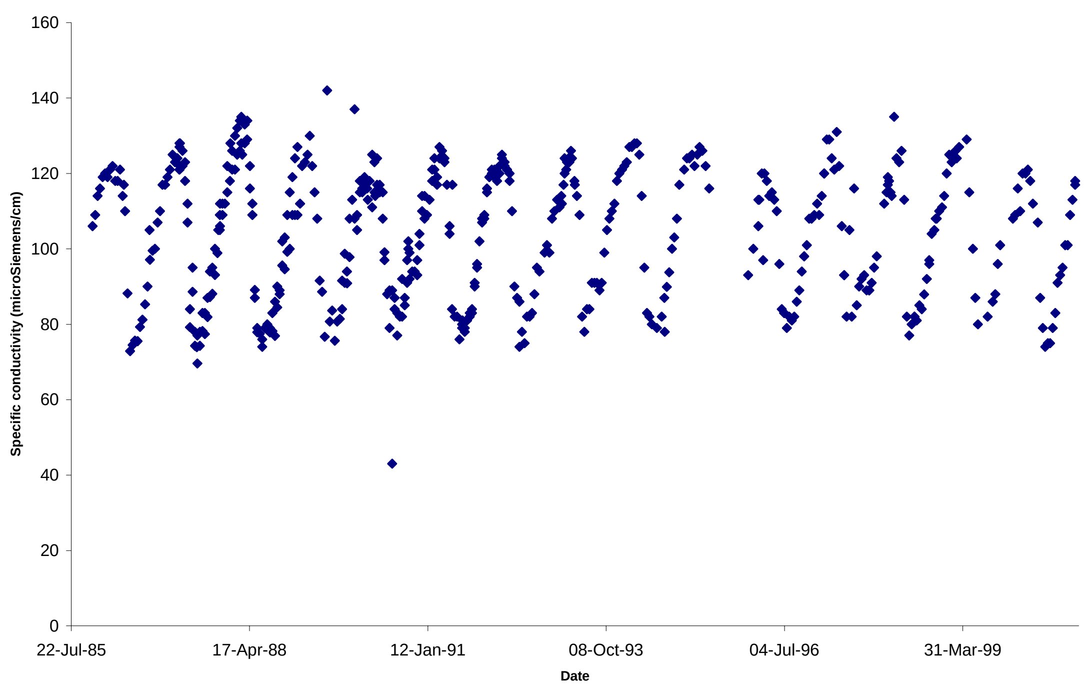

Figure 20. Thompson River at Spences Bridge - Copper, Total, and Turbidity

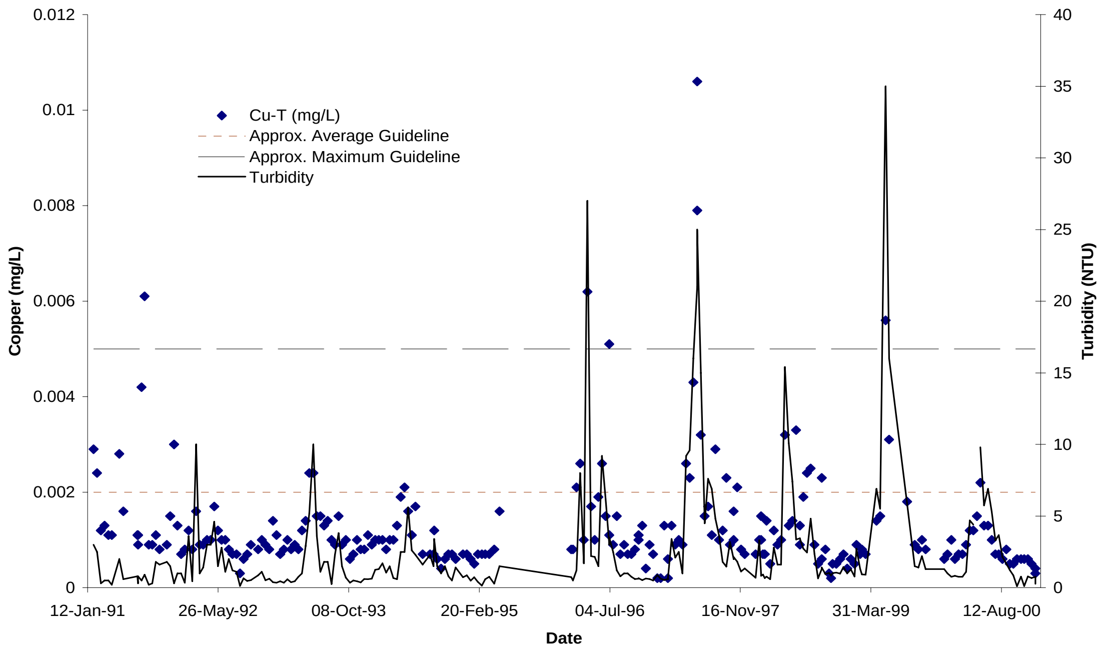

Figure 21. Thompson River at Spences Bridge - Fluoride, Dissolved

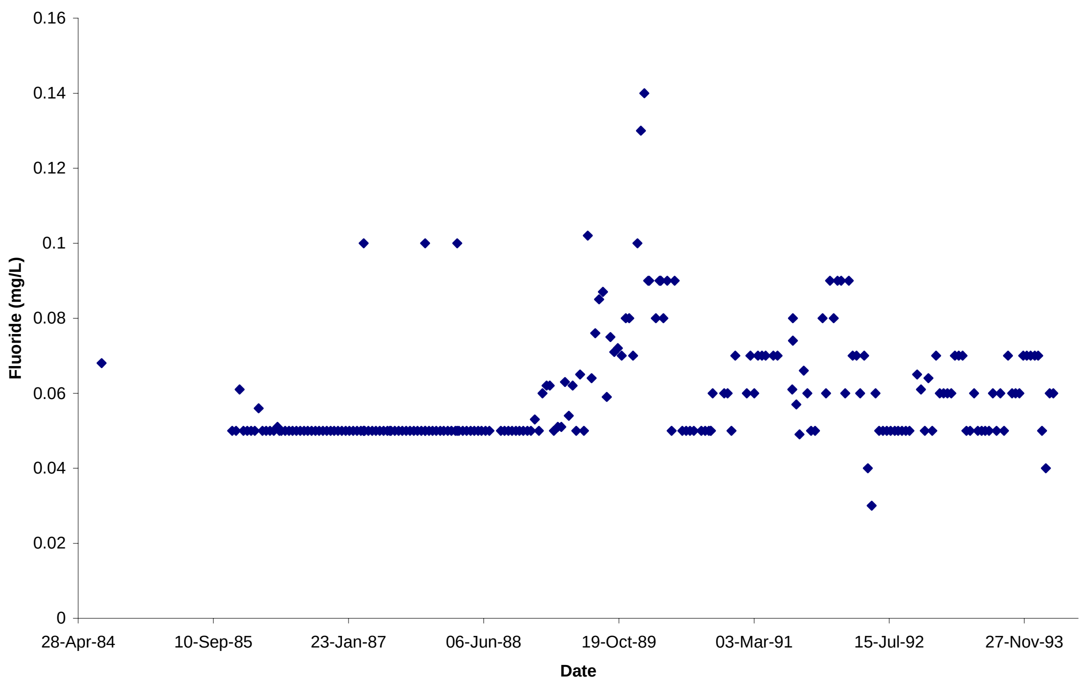

Figure 22. Thompson River at Spences Bridge - Hardness, Dissolved and Extractable

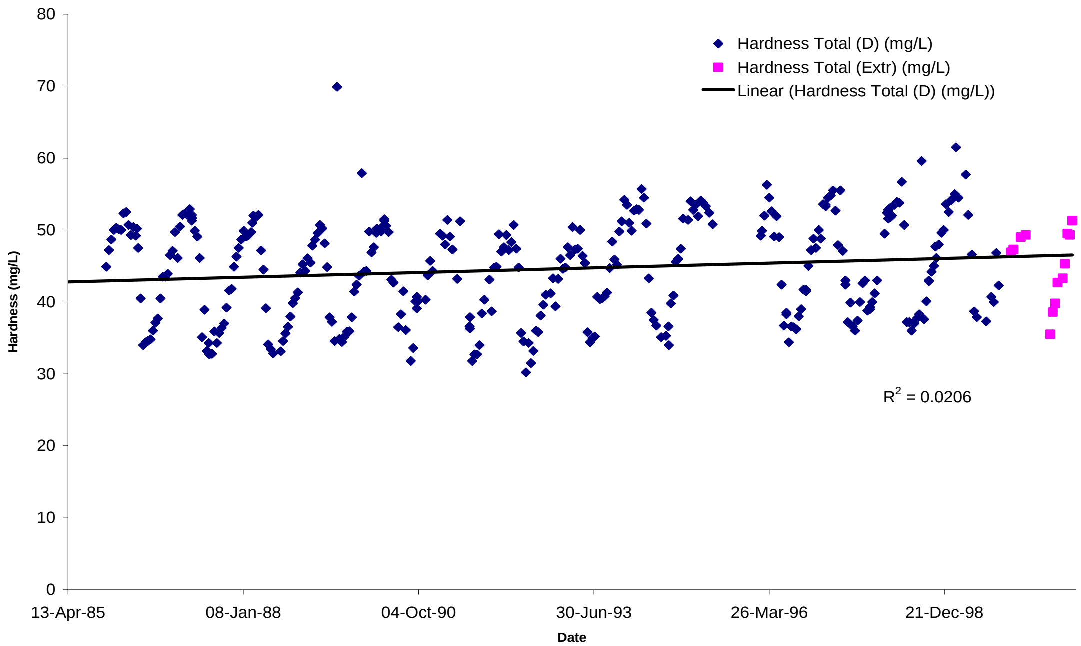

Fig 23. Thompson River at Spences Bridge - Iron, Total

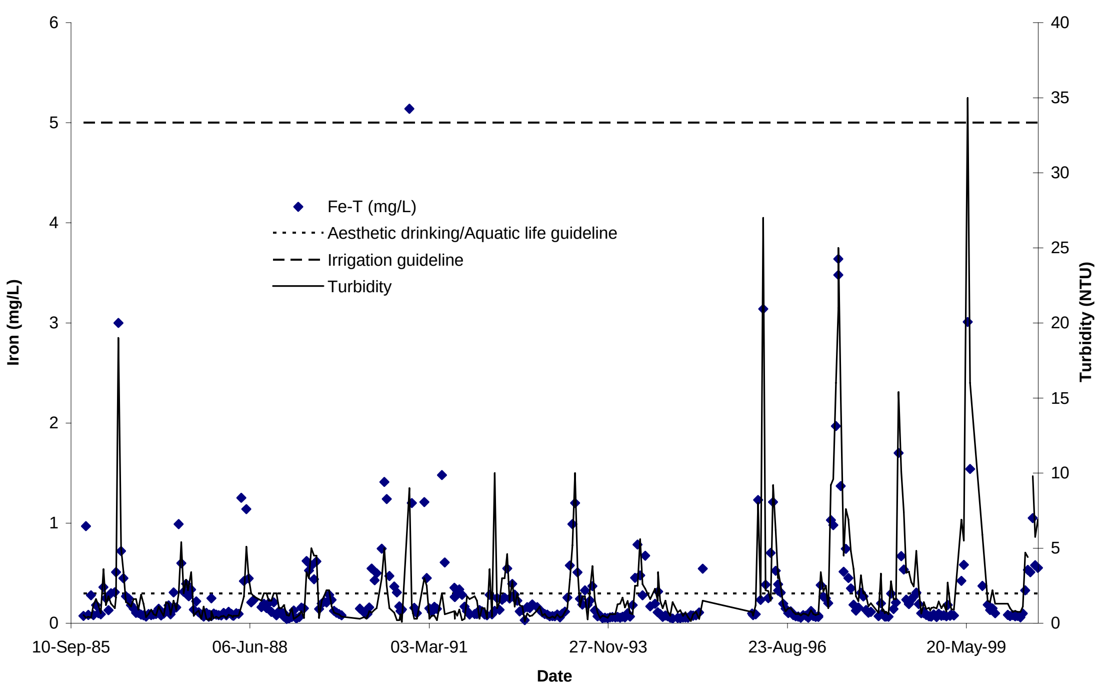

Figure 24. Thompson River at Spences Bridge - Lead, Total

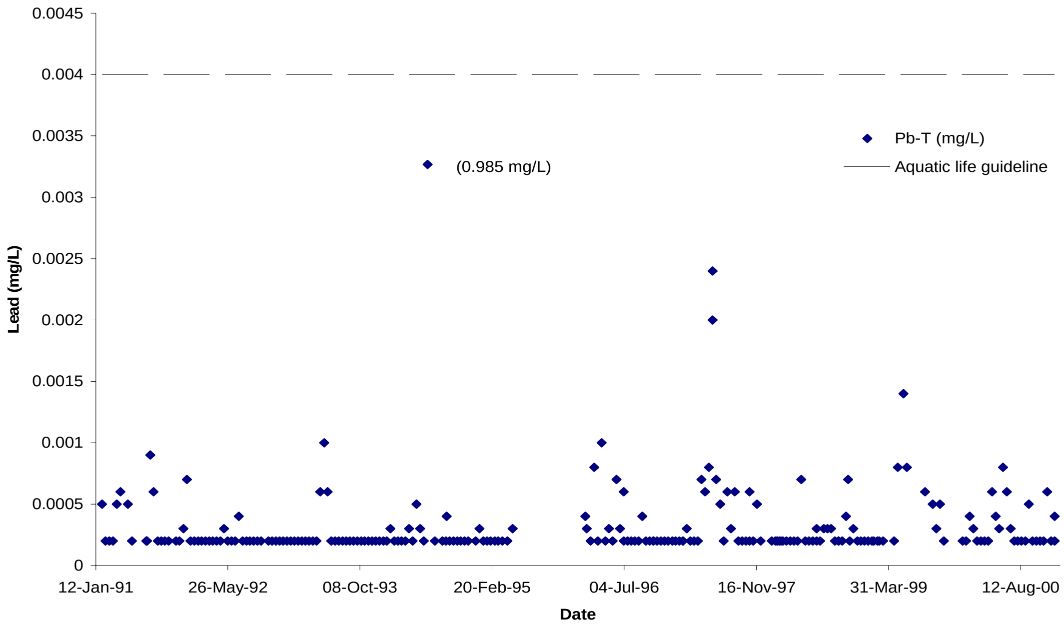

Figure 25. Thompson River at Spences Bridge - Lithium, Total

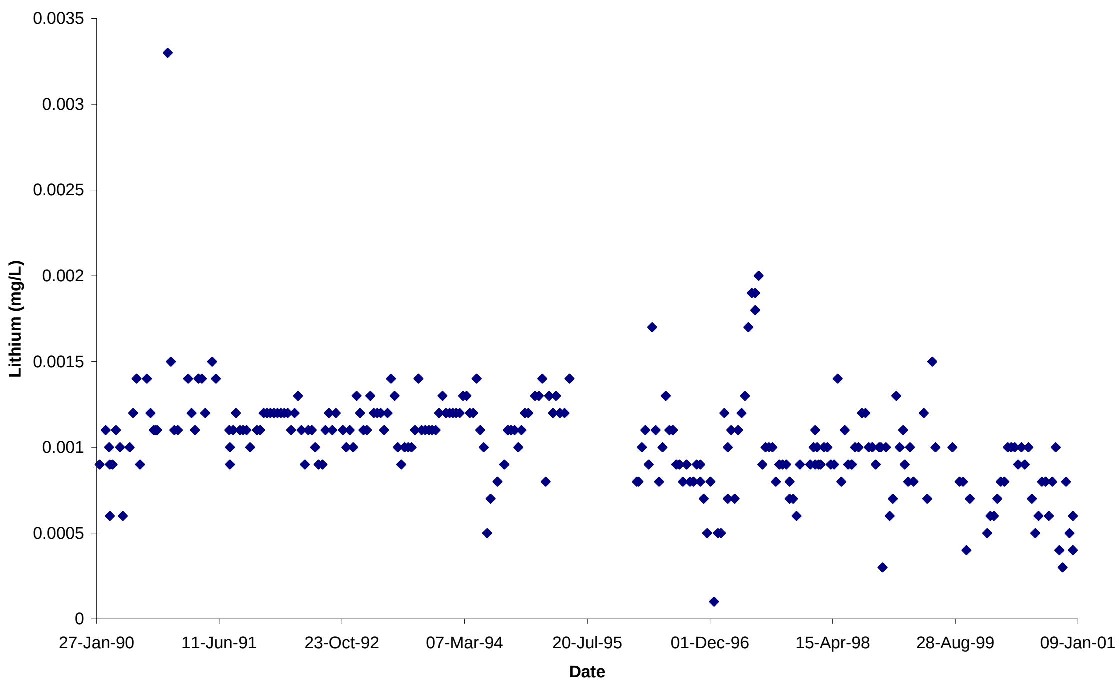

Figure 26. Thompson River at Spences Bridge - Magnesium, Dissolved and Extractable

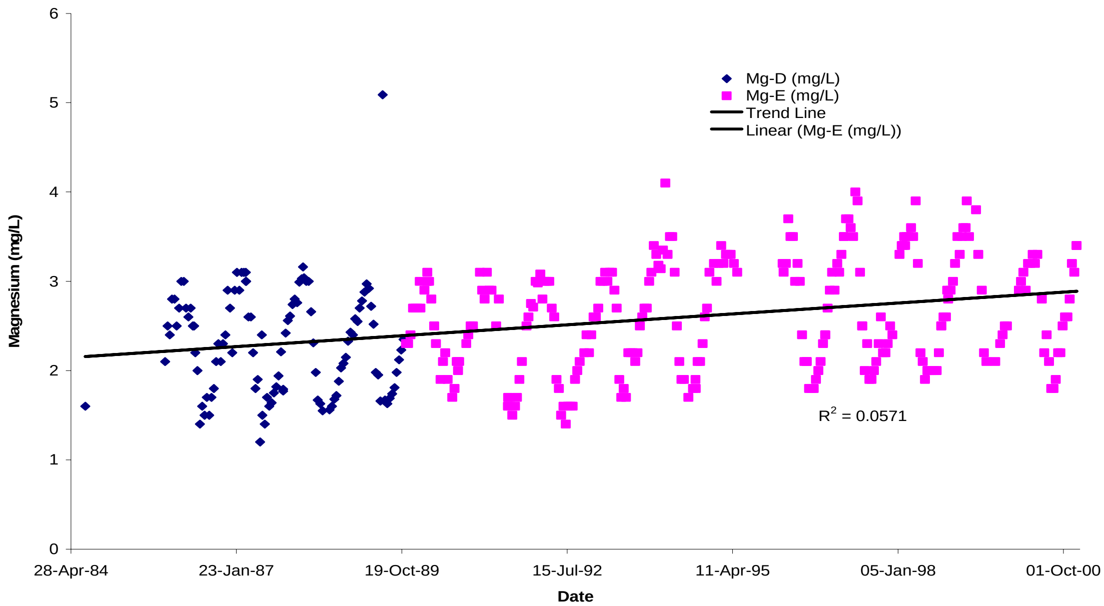

Figure 27. Thompson River at Spences Bridge - Manganese, Total, and Turbidity

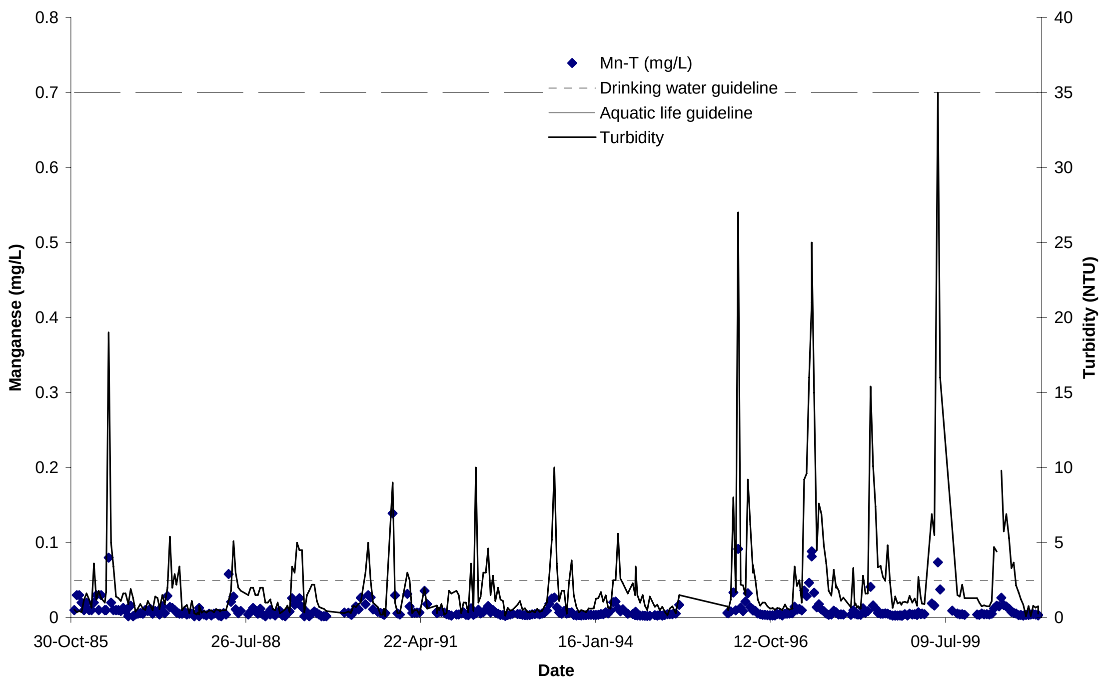

Figure 28. Thompson River at Spences Bridge - Molybdenum, Total

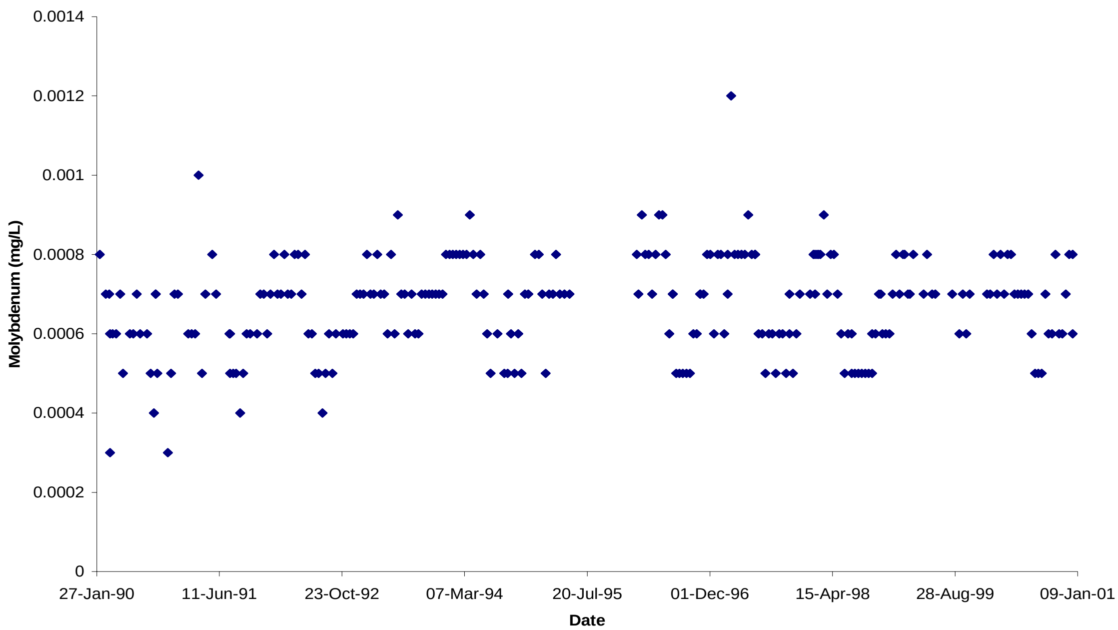

Figure 29. Thompson River at Spences Bridge - Nickel, Total

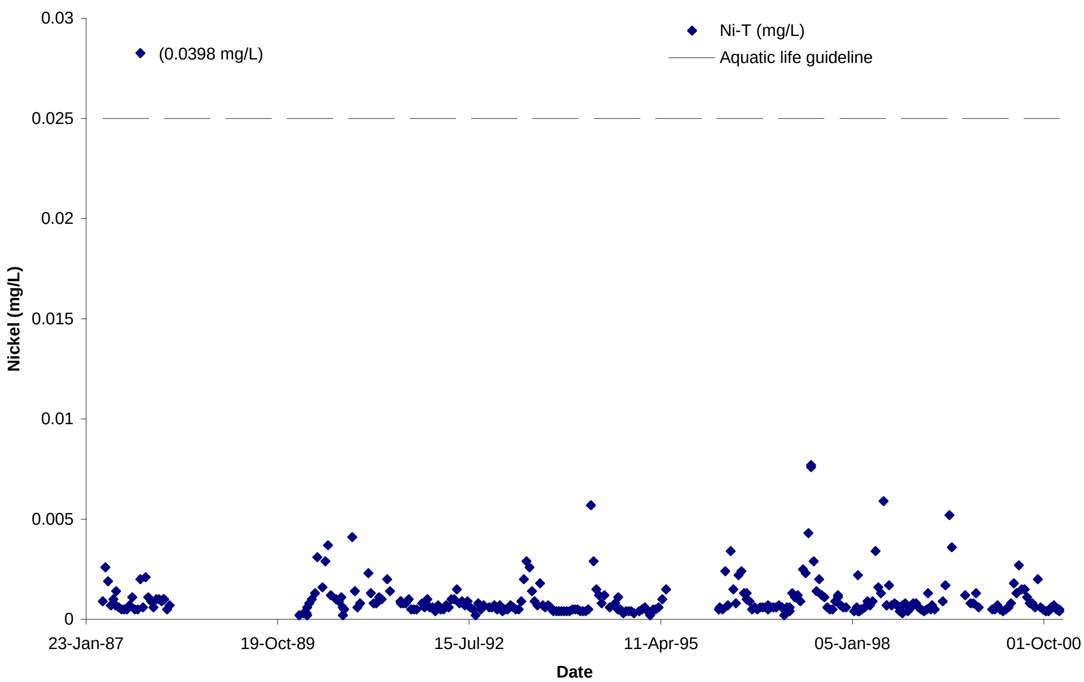

Figure 30. Thompson River at Spences Bridge - Nitrate + Nitrite, Dissolved, as N

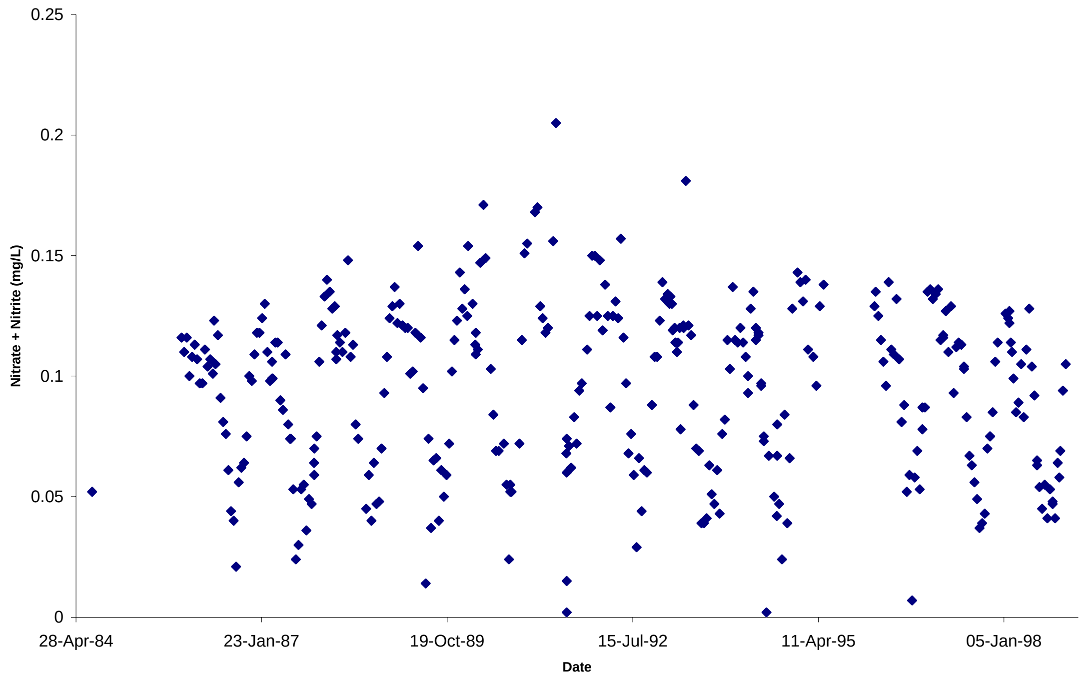

Figure 31. Thompson River at Spences Bridge - Nitrogen, Total Dissolved

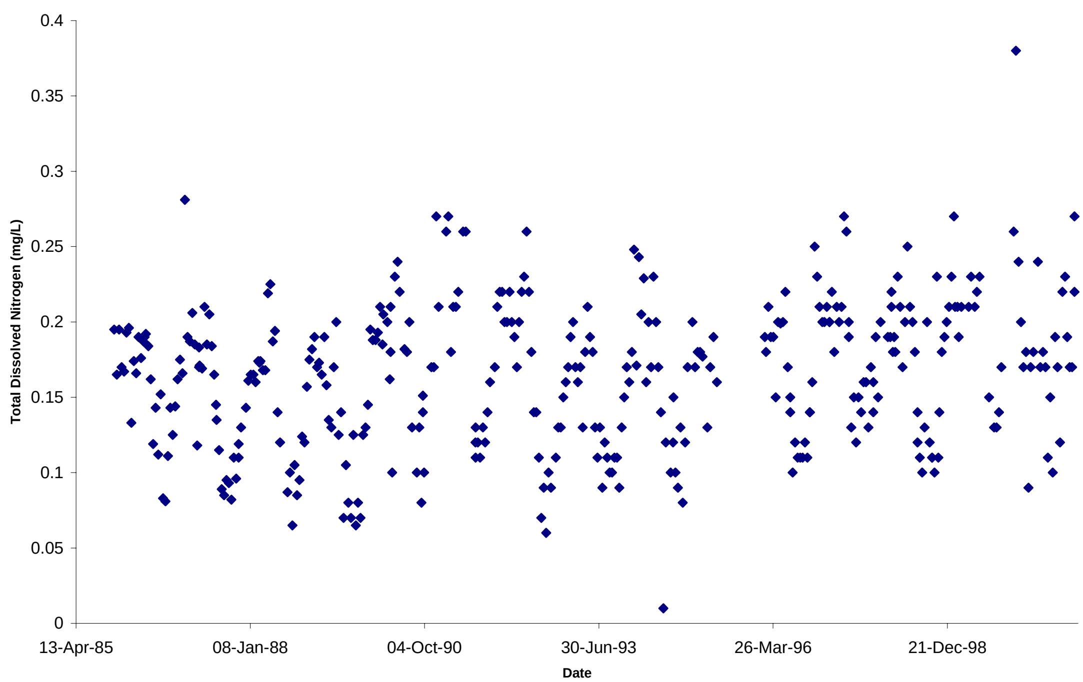

Figure 32. Thompson River at Spences Bridge - Oxygen, Dissolved

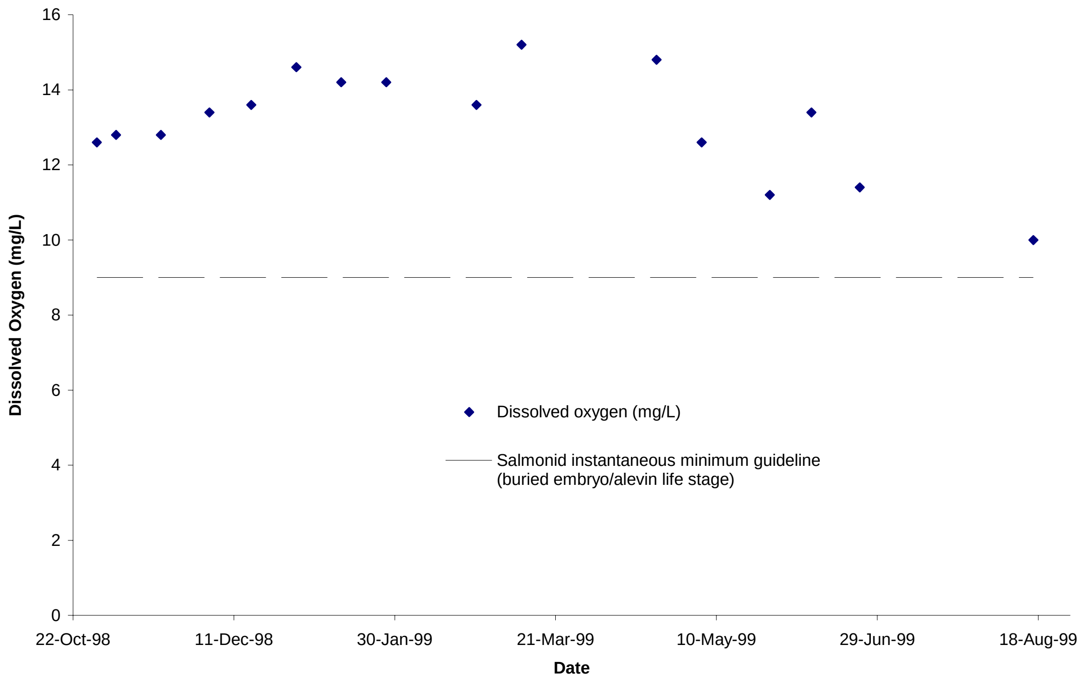

Figure 33. Thompson River at Spences Bridge - pH

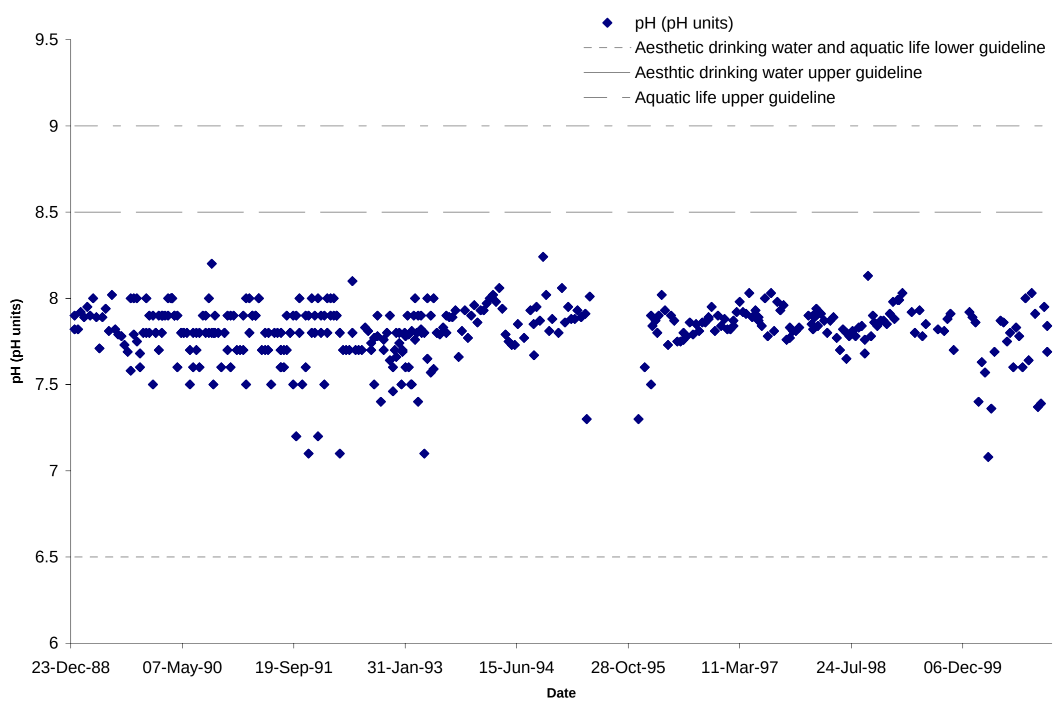

Figure 34. Thompson River at Spences Bridge - Phosphorus, Ortho

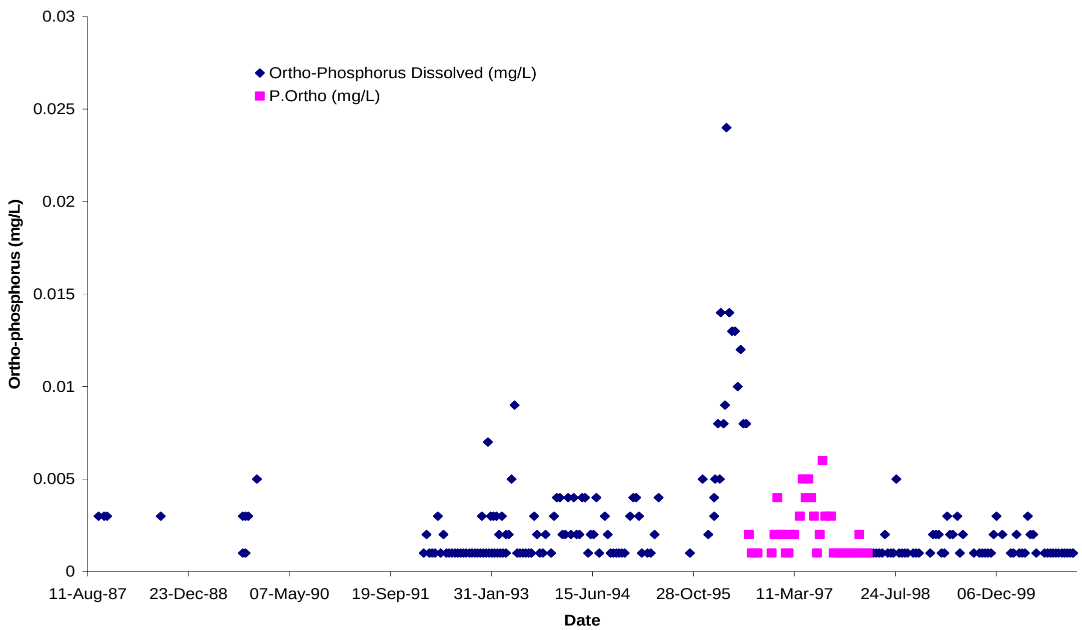

Figure 35. Thompson River at Spences Bridge - Phosphorus, Total Dissolved

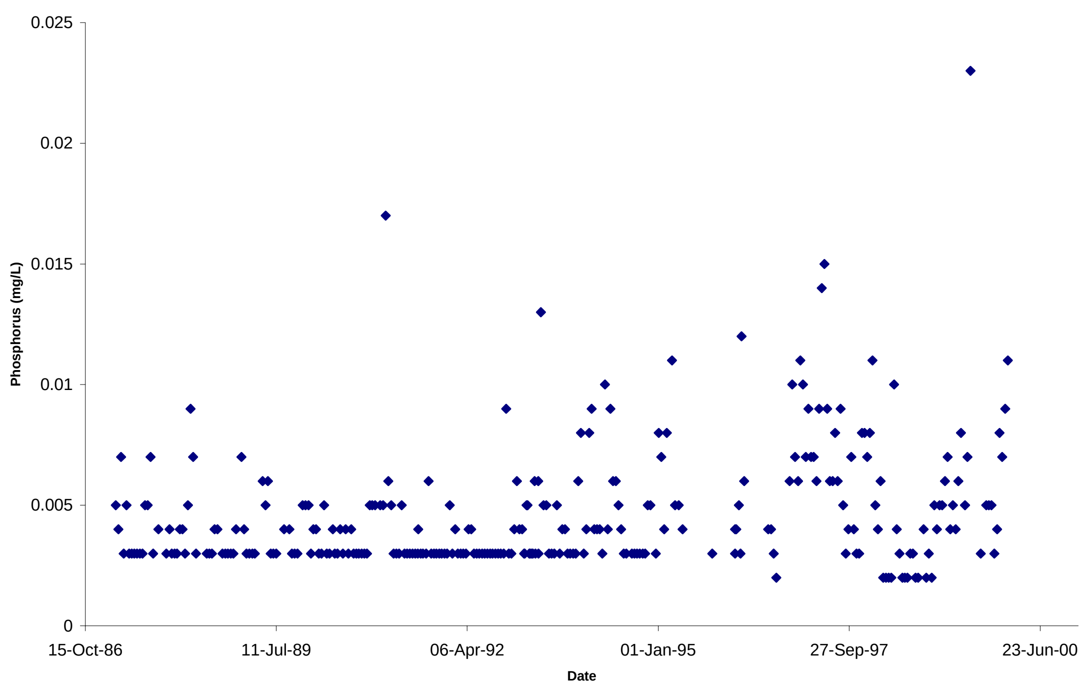

Figure 36. Thompson River at Spences Bridge - Phosphorus, Total

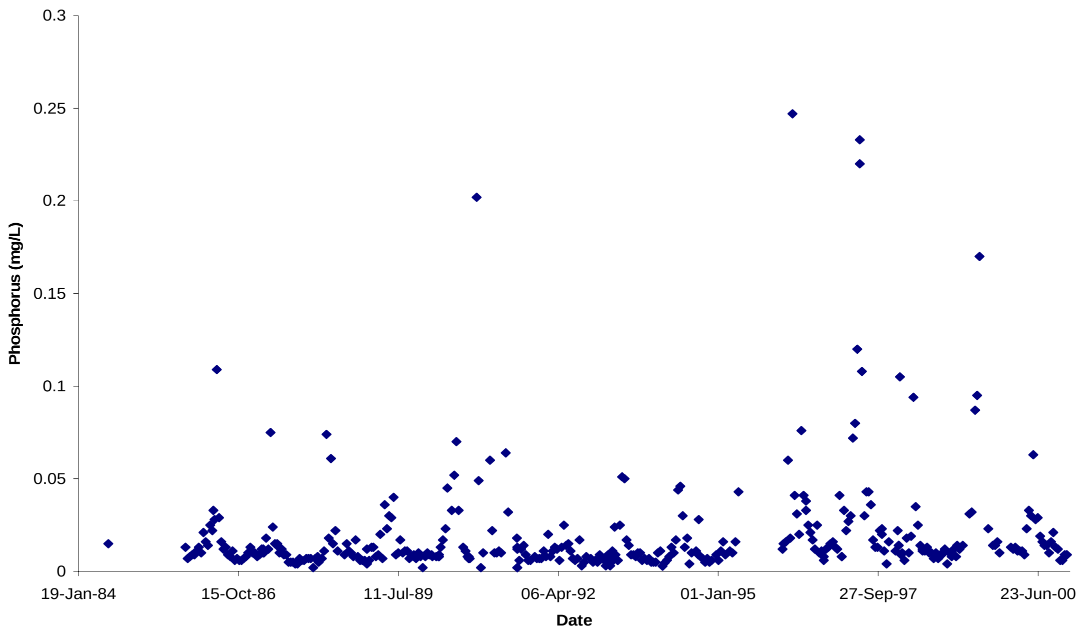

Figure 37. Thompson River at Spences Bridge - Potassium, Dissolved, Extractable

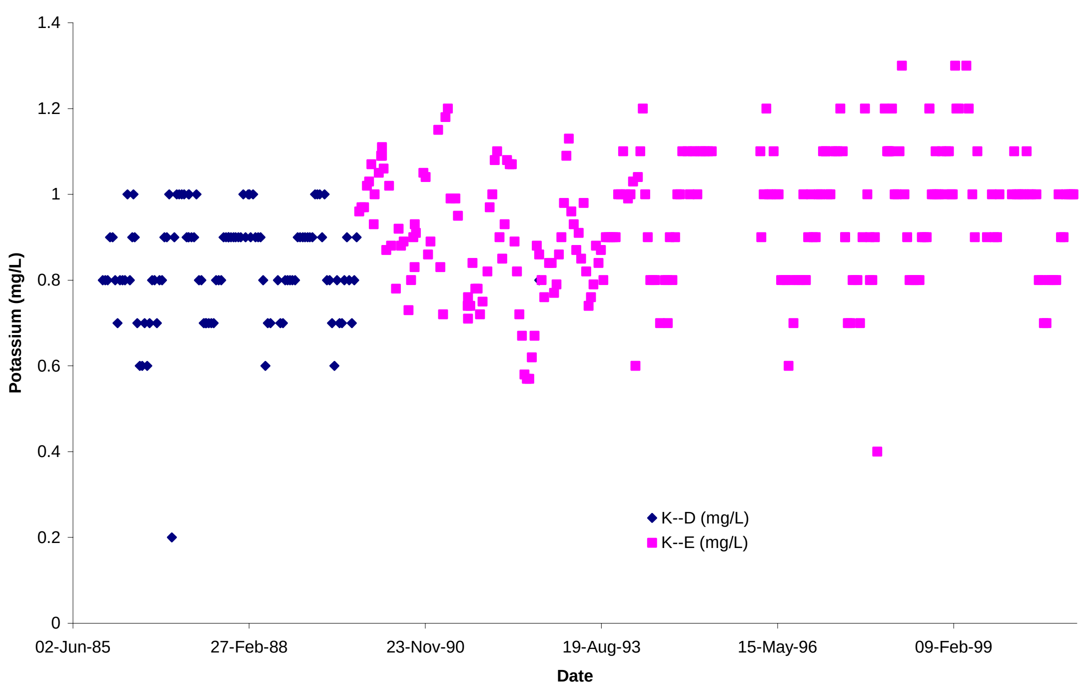

Figure 38. Thompson River at Spences Bridge - Residue, Filterable

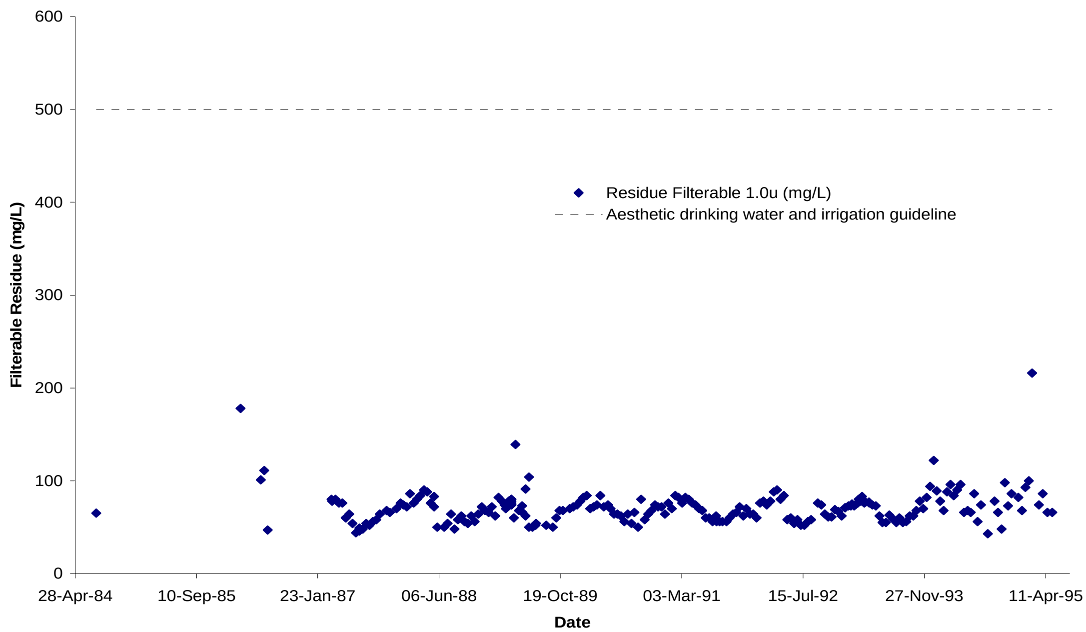

Figure 39. Thompson River at Spences Bridge - Residue, Non-Filterable, and Turbidity

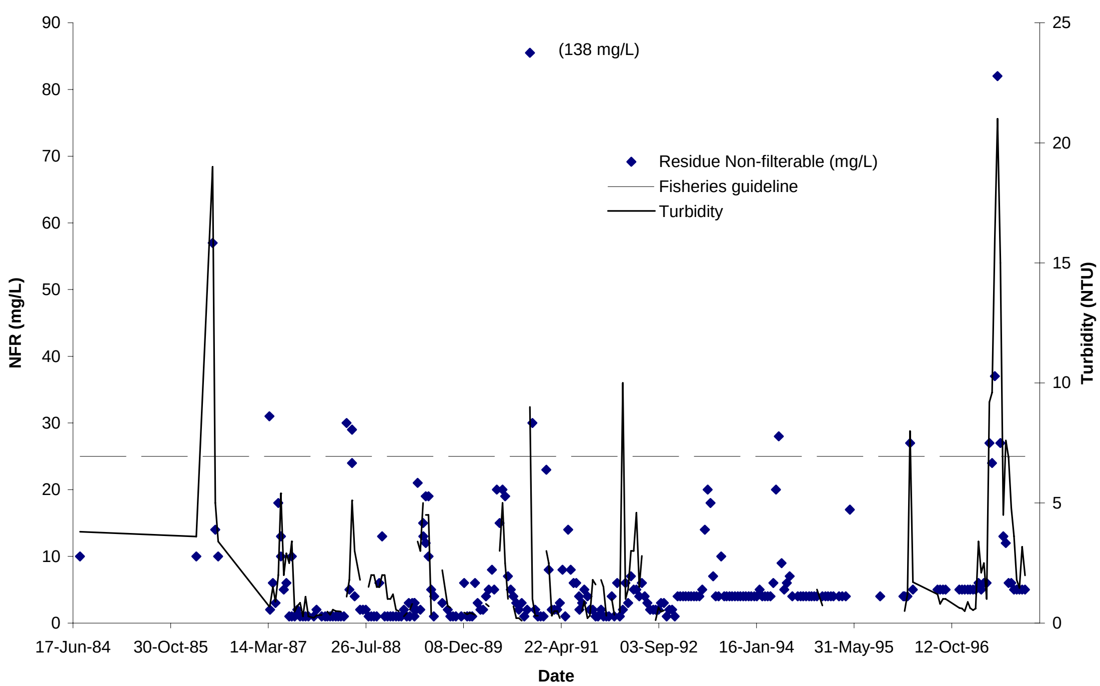

Figure 40. Thompson River at Spences Bridge - Selenium, Total

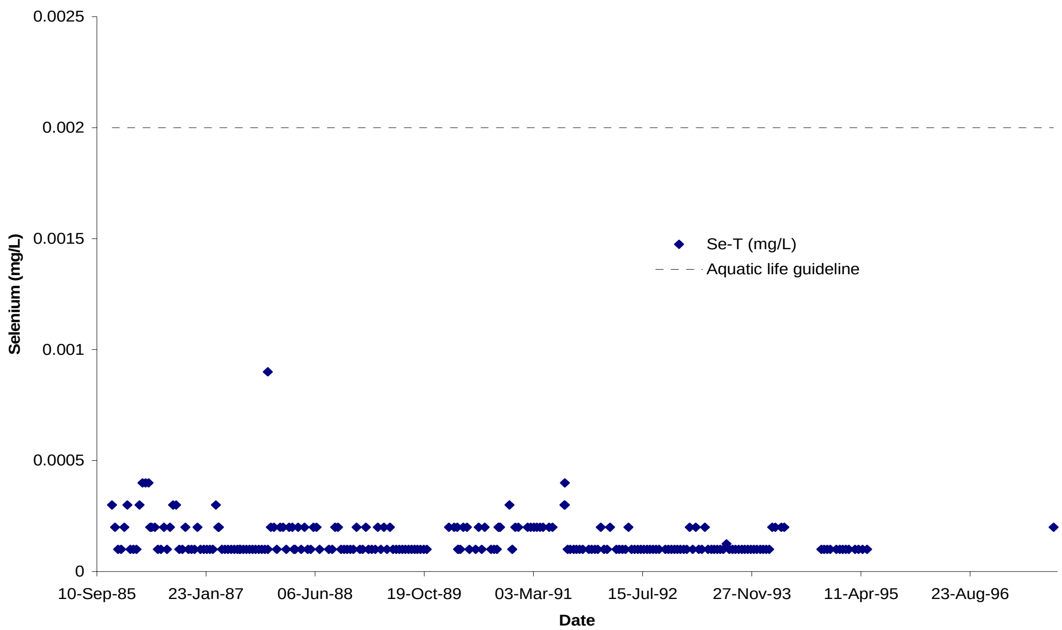

Figure 41. Thompson River at Spences Bridge - Sodium, Dissolved and Extractable

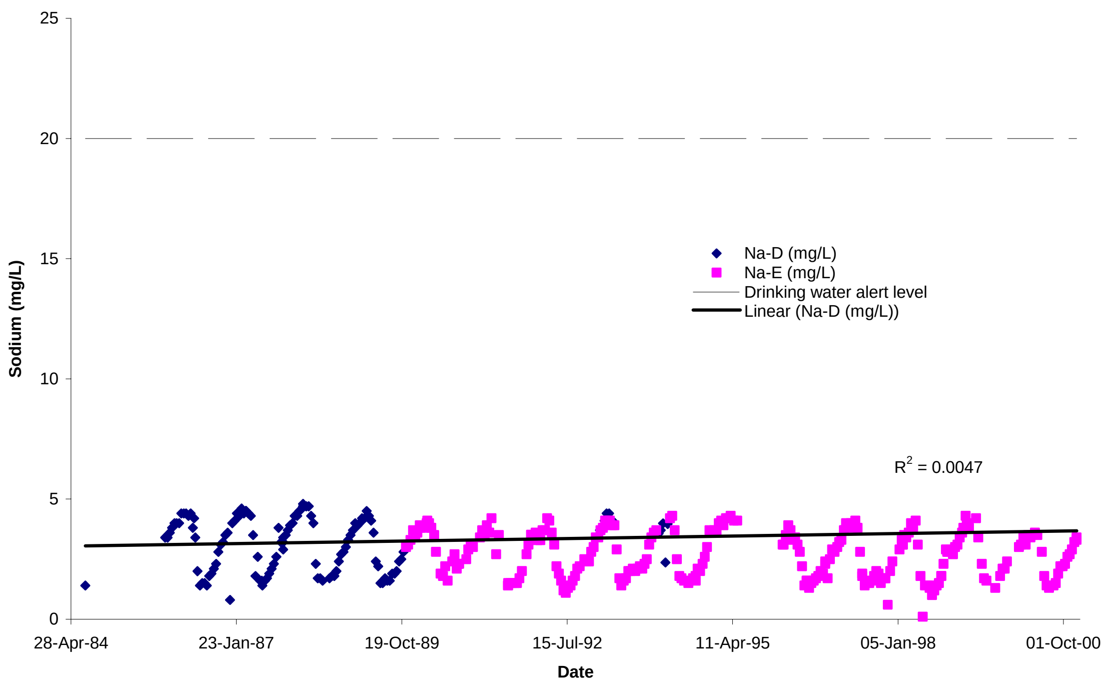

Figure 42. Thompson River at Spences Bridge - Silver, Total

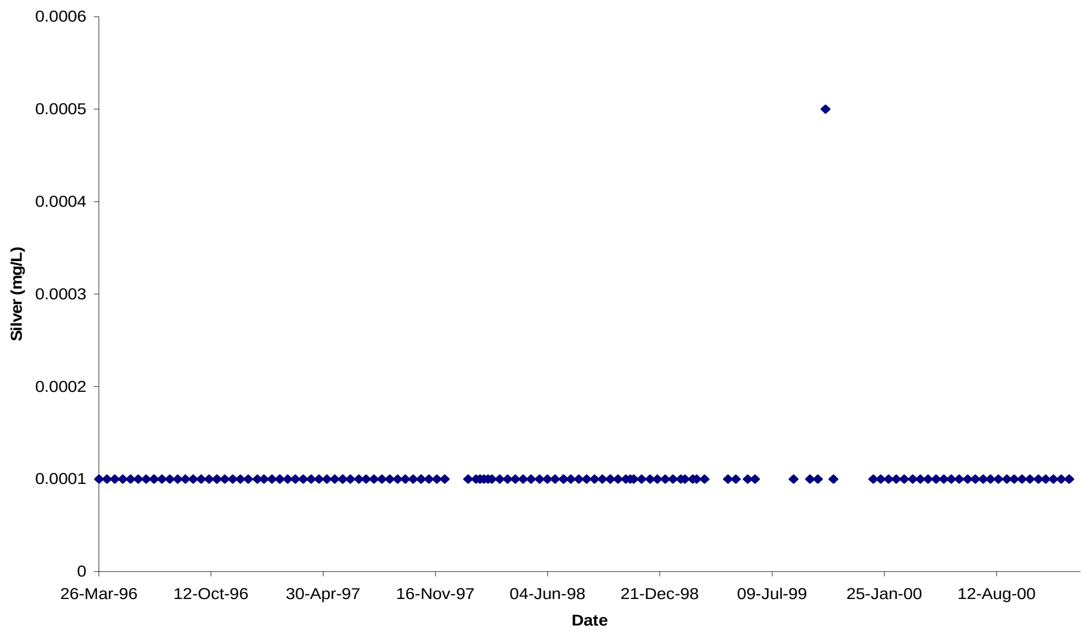

Figure 43. Thompson River at Spences Bridge - Sulphate, Dissolved

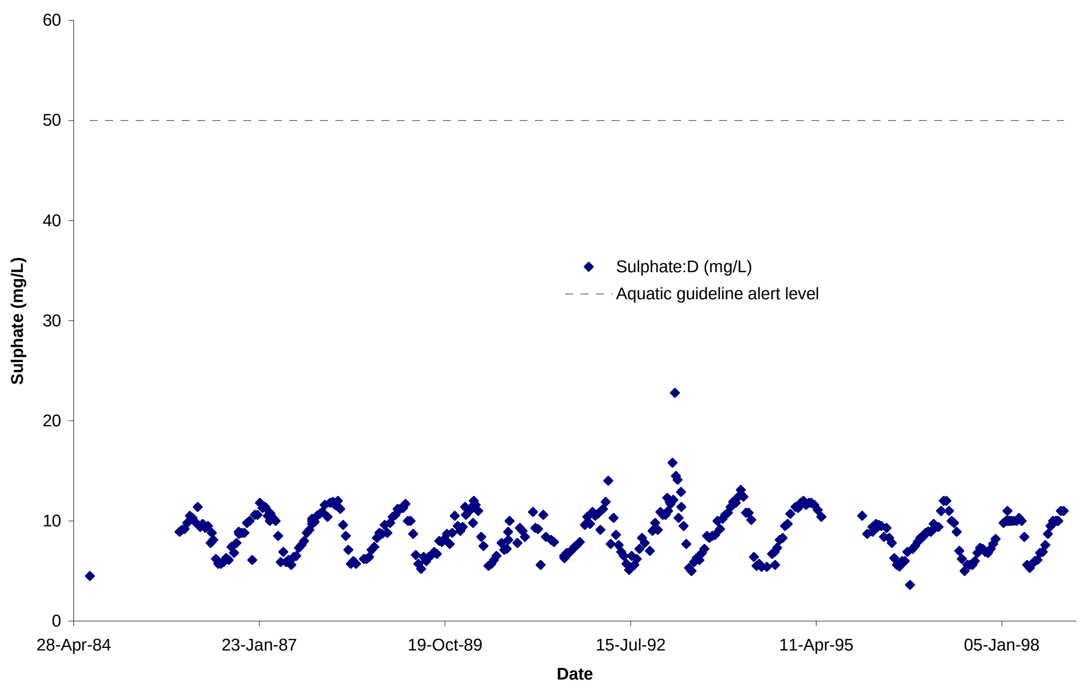

Figure 44. Thompson River at Spences Bridge - Temperature, Water

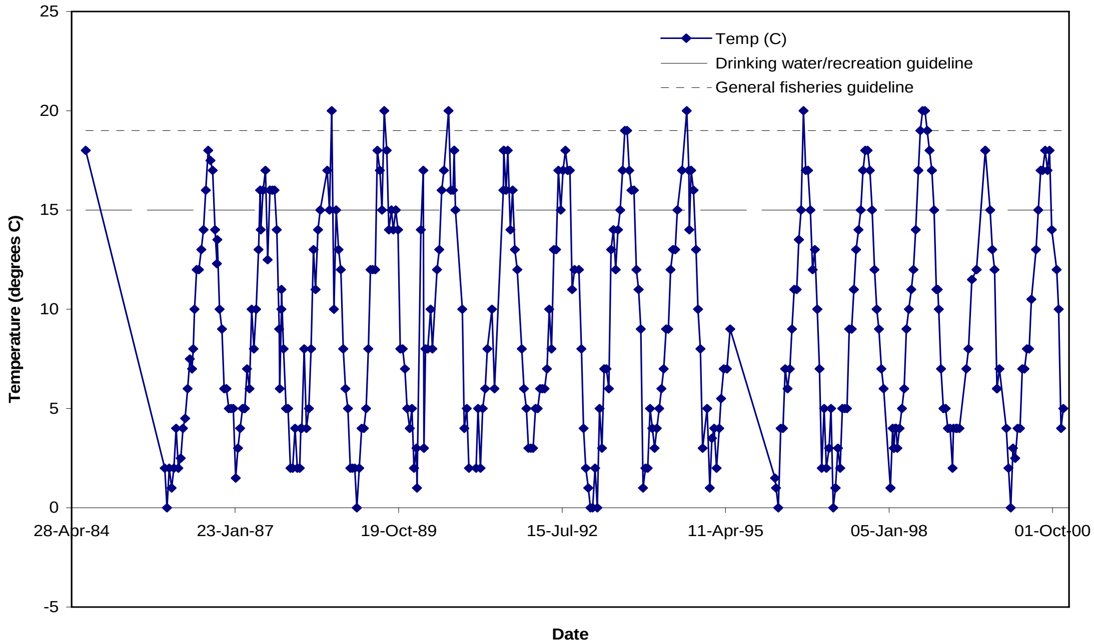

Figure 45. Thompson River at Spences Bridge - Turbidity

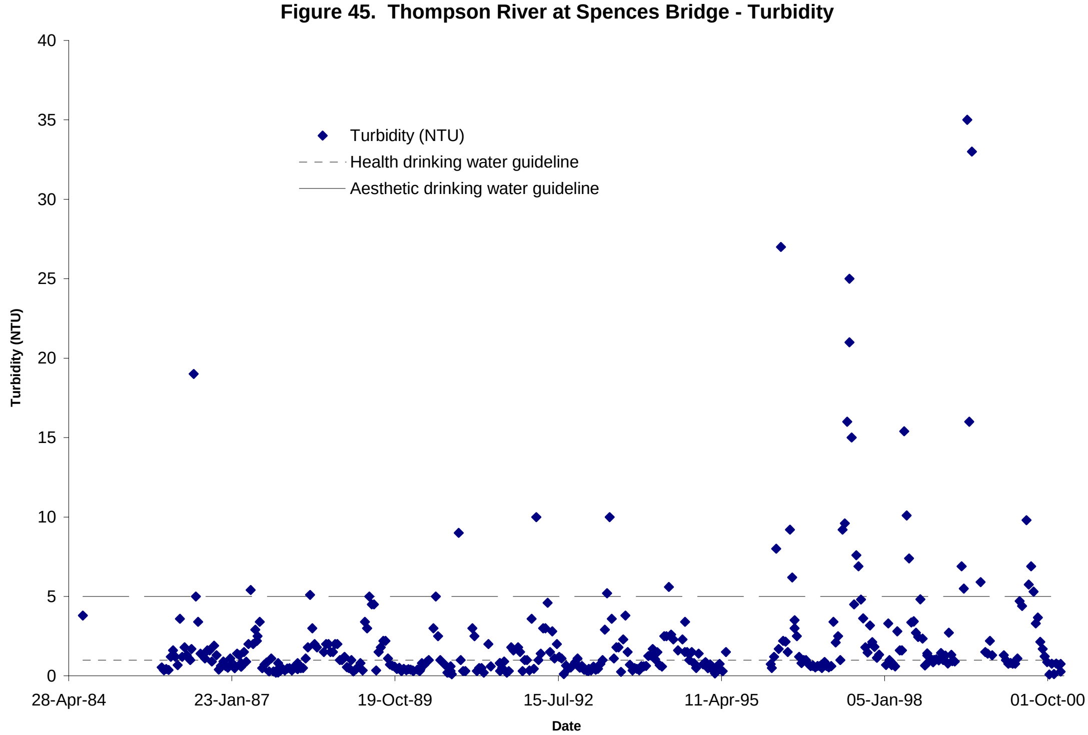

Figure 46. Thompson River at Spences Bridge - Uranium, Total

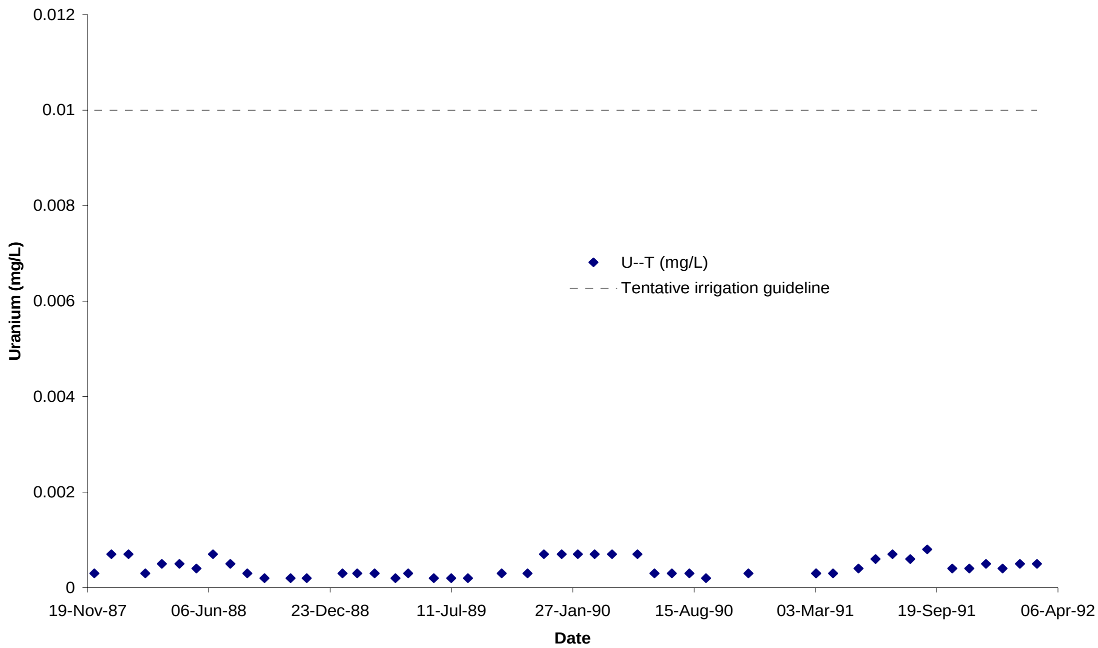

Figure 47. Thompson River at Spences Bridge - Vanadium, Total

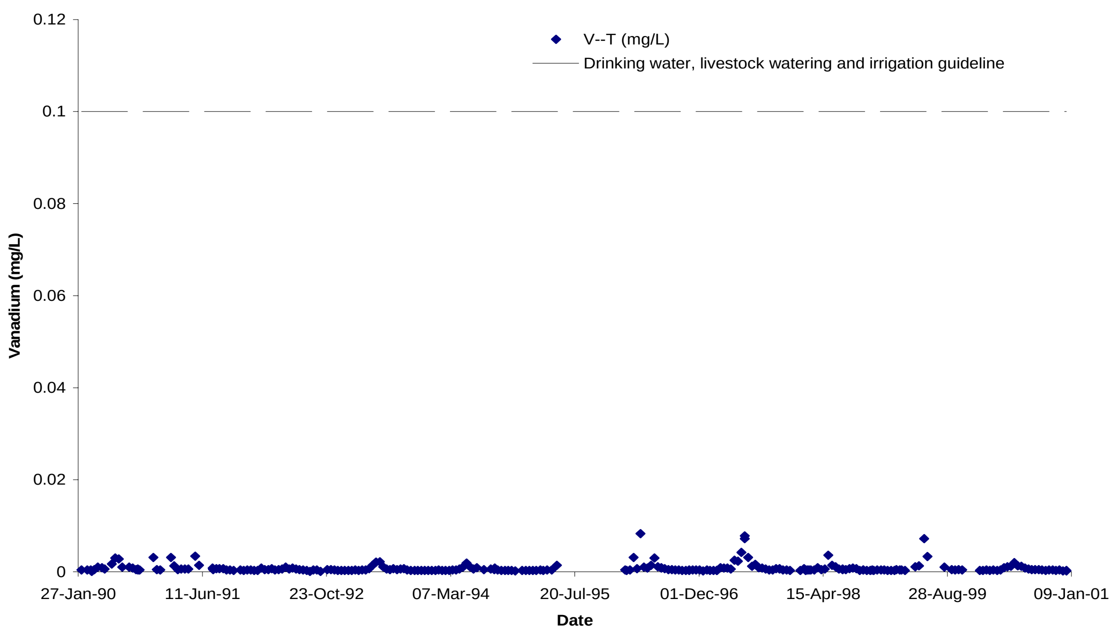

Figure 48. Thompson River at Spences Bridge - Zinc, Total