CANADA – BRITISH COLUMBIA
WATER QUALITY MONITORING AGREEMENT

WATER QUALITY ASSESSMENT OF PEACE RIVER ABOVE ALCES RIVER (1984 – 2002)

BWP Consulting

January 2003

Environment Canada **Environnement Canada**

BRITISH COLUMBIA Ministry of Environment

EXECUTIVE SUMMARY

The Peace River is a major river located in northeastern British Columbia, flowing from the W.A.C. Bennett Dam and Williston Reservoir eastward to the Alberta border (Figure 1). River water quality is important to aquatic life, recreation, livestock watering, industry, wildlife, and irrigation. The Peace River is also a drinking water supply for the Village of Taylor and the District of Hudson's Hope. Direct wastewater discharges from the McMahon gas plant, the Fibreco pulp mill and the City of Fort St. John affect river water quality. Non-point source contributions that affect water quality originate from the agriculture and forestry sectors.

This report assesses water quality data collected at the monitoring station above the Alces River, near the Alberta border. Water quality samples were collected every two weeks during the period from 1984 and 2001. Flow was measured at a Water Survey of Canada flow gauge near Taylor.

CONCLUSIONS

The main conclusions of this assessment are as follows:

- Concentrations of alkalinity and calcium indicate that the water is well buffered and has a low sensitivity to acid inputs.
- Water quality patterns in this watershed are usually closely matched with flow patterns. As a result, increased turbidity and non-filterable residue during spring freshet makes it necessary to treat the water for drinking purposes.
- Elevated levels of dissolved organic carbon and total metals such as aluminum, chromium, cobalt, copper, iron, lead, manganese and zinc are related to seasonal increased flows and associated suspended sediments and thus are largely not biologically available.
- True and apparent colour values also varied seasonally, and are elevated above the drinking water guideline during spring freshet.
- Metals such as arsenic and nickel, as well as pH showed occasional values that exceed their respective guidelines, but these occasional excursions are not likely a cause for concern.

- Fecal coliform concentrations were often high, occasionally exceeding the guideline for drinking water that undergoes partial treatment (i.e., filtration plus disinfection) .
- Water temperatures seldom exceeded the aesthetic drinking water guideline and never exceeded the general fisheries guideline. Recent temperature values seem to have decreased since about 1993, possibly indicating a change in the water release patterns from the WAC Bennett dam. An odd pattern was noted in water temperatures at the station; summer values between 1984 and 1994 were much higher than those from 1995 onwards. These findings will be further investigated to determine if they are reasonable with respect to flow patterns in the river.
- Dissolved chloride may be increasing slightly over time at this site. The cause of this increase is likely a change of analytical techniques with associated detection limits.
- The minimum detectable limit used for cadmium analyses was much too high to determine guideline compliance. Methods with much lower analytical limits (maximum 1/10 the guideline, or 0.000003 mg/L) should be used when they become available.

No remedial activities appear to be necessary at this time.

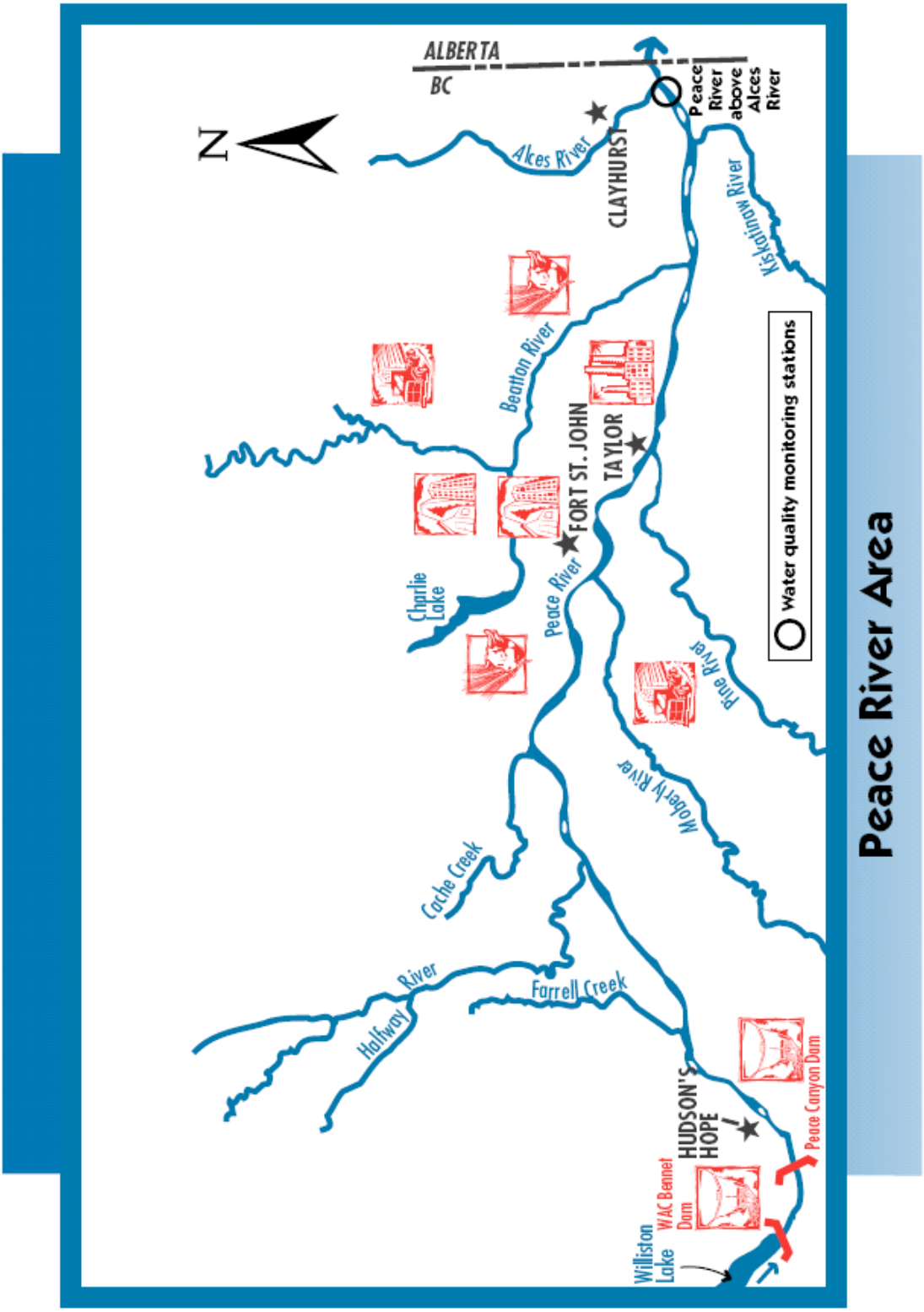
RECOMMENDATIONS

We recommend that monitoring be continued for the Peace River above Alces River because:

- It is the only long-term station on the Peace River.
- It is being used to determine trans-boundary effects ,Alberta maintains a high interest in the quality of water crossing its border, and the river is covered under the Mackenzie River Basin Agreement.
- It is necessary to confirm that the upstream point source discharges (Fibreco Pulp Inc., McMahon Gas Plant, Fort St. John sewage treatment facilities) continue to have no influence on water quality at the provincial border.

- It is being used to determine the impact of non-point sources such as agriculture and forestry.

Figure 1. Peace River above Alces River



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INTRODUCTION

The Peace River is located in northeastern British Columbia, and flows into Alberta. Impounded by the massive W.A.C. Bennett Dam, water leaves the Williston Reservoir clean and clear and flows eastward. Three-quarters of the flow in the Peace River at the Alberta border comes from the Williston Reservoir, while one-quarter is provided by its many tributaries downstream from the Bennett Dam (Butcher, 1987). The Pine River comes from the south and meets the Peace River at Taylor. The Halfway River from the north joins the Peace River 30 km downstream from Hudson's Hope. Other major tributaries are the Beatton River from the north and the Moberly and Kiskatinaw rivers from the south. These tributaries carry non-filterable residue and turbidity from highly erodible soils during the spring freshet and rainfall in the summer and fall, and the high sediment loads are carried into the Peace River. The soils support agricultural and forestry land uses.

The water quality monitoring station above the Alces River is the only site on the Peace River jointly monitored by the federal and provincial governments. The station is located at the bridge across the Peace River south from Clayhurst near the Alberta border. The Peace River drains an area of 118 000 km^2 at this point. Water quality of the Peace River is affected by waste discharges from the City of Fort St. John (into the Peace and Beatton rivers), the McMahon gas processing plant at Taylor, and Fibreco Pulp Inc. at Taylor. This is a CTMP (chemi-thermomechanical pulp) mill which does not use chlorine in the bleaching process. These waste discharges are probably too small and well treated to influence the Peace River at the Alberta border after complete mixing (Pommen, 1996). Agriculture and forestry also have an impact on the Peace River. The river is important for sports fishing, recreation and some irrigation. After partial treatment, the Peace River is also used to supply Taylor and Hudson's Hope with drinking water (Butcher, 1987). Data for this report are compiled from bi-weekly sampling between 1984 and 2002. The federal data are stored under ENVIRODAT station number BC07FD0005; provincial data are stored under the SEAM site number E206585. The water quality indicators are plotted in Figures 3-53. The Water Survey of Canada (WSC) operates a flow gauge

approximately 40 km upstream near Taylor (site number BC07FD002). At this point, the drainage area is 97 100 km^2. Flow data from 1984 to 2002 are graphed in Figure 2.

QUALITY ASSURANCE

The water quality plots were reviewed, and values that were known to be in error or questionable were removed. The total mercury plot has been removed as it showed many detectable values which were probably errors due to false positives near the method detection limits (MDLs) and artificial contamination due to the sample collection and laboratory measurement methods used. Natural mercury levels in pristine areas are typically <1-2 ng/L and are 5-10 ng/L in grossly mercury-polluted waters (Pommen, 1994). These levels are at or below the lowest MDL used for mercury. For these reasons mercury measurement in the ambient water quality monitoring network was terminated in 1994. Mercury in resident fish tissue would be monitored if there were any mercury concerns upstream in this watershed.

There were known quality assurance problems for a number for trace metals and cyanide between 1986 and 1991, due to the gradual failure of the re-usable Teflon liners in the bakelite preservative vial caps. Over time, preservatives would leach out contaminates from the bakelite vial caps and contaminate many preserved water samples. This contamination problem was known to affect federal and federal-provincial water quality data province-wide. The primary variables affected were cadmium, chromium, copper, cyanide, lead, mercury, and zinc during this sampling period. There were also known quality assurance problems for pH between 1986 and 1988, due to analytical problems at the Environment Canada Laboratory during that period.

STATE OF THE WATER QUALITY

The state of the water quality is assessed by comparing the values to B.C. Environment's *Approved and Working Criteria for Water Quality* (Nagpal, Pommen & Swain, 1995). There are no site-specific water quality objectives for the Peace River. All comments and observations regarding apparent trends are based solely on the visual examination of the graphically displayed data.

Any levels or trends in water quality that are deleterious to sensitive water uses, including drinking water, aquatic life and wildlife, recreation, irrigation, and livestock watering, are noted. Variables that exhibited no apparent environmental problems have not been discussed although all of these variables have been plotted and included in this report. These include barium, beryllium, boron, bromide, total carbon, total dissolved carbon, cyanide (WAD and SAD+SCN), gallium, hardness, lanthanum, lithium, magnesium, molybdenum, Kjeldahl nitrogen, nitrate/nitrite, total nitrogen, phosphorus, potassium, filterable residue, rubidium, silica, silicon, silver, sodium, strontium, sulphate, thallium, uranium and vanadium.

Concentrations of **alkalinity** (Figure 3) and **dissolved and extractable calcium** (Figure 11) indicate that the Peace River above the Alces River is well buffered against acidity.

Concentrations of **total aluminum** were often high, with a maximum concentration of 26.4 mg/L (Figure 4). 183 of the 246 samples (74%) collected between 1987 and 2002 exceeded the aquatic life guideline of 0.1 mg/L for dissolved aluminum, and 121 samples (49%) exceeded the drinking water guideline of 0.2 mg/L. However as only total aluminum was measured, an accurate assessment of compliance with this guideline cannot be made. It must also be noted that total aluminum concentrations were strongly correlated with turbidity values (see Figure 4), suggesting that higher levels of aluminum were associated with particulate matter. In this case, they would likely be unavailable to biota, and would also be removed by treatment necessary for reducing turbidity prior to consumption as drinking water. Fifteen values (6% of samples) exceeded the wildlife, livestock watering and irrigation guideline of 5 mg/L total aluminum.

Total arsenic concentrations exceeded the aquatic life guideline of 0.005 mg/L on 14 occasions (5% of the 258 samples collected) (Figure 5). However, as there was a strong correlation with turbidity, it is likely that the majority of the arsenic present was associated with particulate matter and therefore not biologically available. **Extractable arsenic concentrations were all below the guideline.**

Total cadmium concentrations invariably exceeded the aquatic life guideline of 0.00003 mg/L (Figure 10), but this was partially due to the fact that the detection limits used in the analyses were between 30 and 300 times higher than the guideline limit. However, 27 of 40 values (68%) of **extractable cadmium** measured between 1996 and 2002 using a lower detection limit (0.000005 mg/L) also exceeded the aquatic life guideline, suggesting that cadmium concentrations may be a concern in the Peace River. In order to properly assess cadmium concentrations, it is essential that analytical methods with a detection limit of no more than one-tenth the guideline level be employed when they become available.

Dissolved organic carbon concentrations were below the drinking water guideline during the winter months, but usually exceeded this value (4 mg/L) during the spring freshet and through the summer (Figure 13). 12 of 57 values (21%) collected between 1997 and 2001 exceeded this guideline.

Dissolved chloride concentrations appear to be decreasing over time in the Peace River above the Alces River (Figure 14). There is currently no guideline for chloride, and this decrease is unlikely to be environmentally significant. It is likely that this apparent trend is a result of the change in methodology in mid-1991 from an automated colorimetric method to ion chromatography.

Total chromium concentrations measured prior to 1991 (Figure 15) may have been elevated due to suspected preservative vial contamination. Since that time, 104 samples (50% of the 208 samples collected between 1987 and 2002) exceeded the aquatic life guideline of 0.001 mg/L, with a maximum concentration of 0.0369 mg/L. Thirty-eight values (18% of samples) exceeded the irrigation guideline of 0.005 mg/L. Three of 40 recent **extractable chromium** concentrations also exceeded the aquatic life guideline. It appears that elevated levels of total chromium are associated with elevated turbidity, suggesting that the chromium is associated with particulate matter and therefore not likely available to biota (Figure 15).

Total cobalt concentrations exceeded the aquatic life guideline of 0.0009 mg/L in 23% of samples between 1987 and 2002 (Figure 15). The irrigation guideline of 0.05 mg/L was not exceeded on any occasion. Recent extractable cobalt concentrations illustrated similar patterns as exhibited by the total concentrations. Elevated concentrations of total cobalt occurred at the same time that turbidity levels were elevated, suggesting that the cobalt was associated with particulate matter and therefore not likely available to biota.

The 90th percentile value for **fecal coliforms** collected between 1997 and 2001 could not be calculated due to insufficient sampling frequency, and therefore the drinking water guideline could not be properly assessed. However, the fact that only 1% of values (4 of 243 values) exceeded the 90th percentile guideline of 100 CFU/100 mL for water undergoing partial treatment as well as disinfection (Figure 17) suggest that coliforms are not likely a problem for drinking water in the Peace River and reinforces that the partial treatment beyond simple disinfection is necessary.

True colour values showed a strong seasonal variation, with regular increases to above the aesthetic drinking water guideline of 15 TCU occurring during the spring and summer (Figure 18). True colour values ranged from below detectable limits (< 5 TCU) to a maximum of 200 TCU on August 8, 2001. High colour levels can indicate the presence of organic materials that, during water treatment with chlorine for disinfection, can cause the formation of trihalomethanes.

Specific conductivity values were fairly consistent in the Peace River above the Alces River, fluctuating near 200 µS/cm for most of the year (Figure 19). All values were well below the guideline for drinking water of 700 µS/cm.

Total copper samples collected between 1988 and 1991 are suspect due to preservative vial contamination. Outside of that period, 80 values (32% of 248 samples) exceeded the hardness-dependent average aquatic life guideline and 34 values (14%) exceeded the maximum guideline (Figure 20). There was a strong correlation between copper and

turbidity (see Figure 20), suggesting that most copper was associated with particulate matter and therefore would likely not be toxic to aquatic life. Recent **extractable copper** concentrations also seem to be influenced by turbidity concentrations.

The aquatic life guideline for **dissolved fluoride** is hardness dependent – at a hardness greater than 50 mg/L (typical for the Peace River above the Alces River, see Figure 24), the guideline is 0.3 mg/L. This guideline was not exceeded by any samples (Figure 22).

Total iron concentrations usually exceeded the aquatic life and aesthetic drinking water guideline of 0.3 mg/L (61% of 285 samples) (Figure 24). As well, the irrigation guideline of 5 mg/L was exceeded by 13% of samples. However, there was a strong correlation between iron and turbidity fluctuations, suggesting that higher concentrations of iron were associated with particulate matter and were therefore not likely biologically available. Iron would be removed by treatment necessary to decrease turbidity prior to use as drinking water.

Concentrations of **total lead** measured between 1988 and 1991 are suspected to be contaminated as a result of faulty preservative vial seals. Outside of this period, 21 values (8% of samples) exceeded the average hardness-dependent aquatic life guideline of approximately 0.004 mg/L and no values exceeded the maximum guideline (Figure 27). All exceedences of the average guideline occurred during periods of elevated turbidity (see Figure 27). Total lead concentrations seem to fluctuate with turbidity concentrations, suggesting that higher lead values are likely not biologically available. Recent **extractable lead** concentrations also seem to follow this same pattern.

Fifty-five **total manganese** concentrations (19% of all samples) exceeded the drinking water guideline of 0.05 mg/L, with a maximum value of 1.1 mg/L occurring on July 4, 1994 (Figure 30). Thirteen of these values (5%) also exceeded the irrigation guideline of 0.2 mg/L, and one sample exceeded the aquatic life guideline of 0.8 mg/L. Higher manganese values tend to reflect turbidity values. Recent **extractable manganese** values seem to be following the same pattern. Elevated levels of total manganese occurred

concurrently with higher turbidity levels, suggesting that treatment to remove turbidity prior to entering the drinking water supply would remove much of the manganese.

Total nickel concentrations were generally below the aquatic life guideline of 0.025 mg/L (Figure 32). Eight values exceeded this guideline, with a maximum value of 0.0474 mg/L occurring on July 4, 1994. The similar patterns in concentrations between total nickel concentrations and turbidity suggest that much of the nickel is associated with particulate matter and therefore not likely toxic to aquatic life. Recent **extractable nickel** values seem to vary with turbidity.

The majority of **pH** values were between 8.0 and 8.5 pH units, and were within the drinking water guidelines which recommend a range of 6.5 to 8.5 pH units (Figure 33). The exceptions were four values ranging from 8.57 to 8.93 pH units, measured between May 10, 1995 and December 14, 2000.

Non-filterable residue (total suspended solids) concentrations were seasonally correlated, with maximum values occurring annually during spring freshet. Values were occasionally extremely high, ranging from below detectable limits (< 1 mg/L) to a maximum of 3880 mg/L (Figure 40). Thirty-five percent of values exceeded the general fisheries guideline of 25 mg/L.

None of the 245 samples analyzed for **total selenium** between 1984 and 2002 exceeded the aquatic life guideline of 0.002 mg/L (Figure 42). One sample had an **extractable selenium** concentration above this level (0.0045 mg/L), but it is not likely that selenium is a concern in the Peace River.

Water temperatures in the Peace River above Alces exceeded the aesthetic drinking water guideline (15°C) in two summers between 1984 and 2002 (Figure 48). The maximum recorded temperature was 18°C, on August 2, 1993. The general fisheries guideline of 19°C was never exceeded. There is an odd pattern in water temperatures at this site: summer water temperatures between 1984 and 1994 routinely reached highs in

the mid to upper teens in July/August. From 1995 onwards however, summer water temperatures never increased above 5^{o}C. This may be due to changes in release patterns of water from the WAC Bennett dam. These results will be further investigated to determine if they are reasonable.

As expected, **turbidity** values followed a trend similar to that of non-filterable residue, with maximum values occurring during the spring freshet (Figure 50). A number of values were extremely high (> 700 NTU), and 91% of values exceeded the health drinking water guideline of 1 NTU. However, since partial treatment is provided to the drinking water supplies, this low guideline is not appropriate. Fifty-six percent of values (149 of 268 samples) exceeded the aesthetic drinking water guideline of 5 NTU, and 19% of values exceeded the aesthetic recreation guideline of 50 NTU.

Two hundred and eighty-five samples were analyzed for **total zinc** concentrations between 1984 and 2002 (Figure 53). Of these, 55 (19%) exceeded the hardness-dependent aquatic life guideline for average concentrations and 26 values (9%) exceeded the aquatic life guideline for maximum concentrations . Zinc concentrations seem to be well correlated with turbidity (Figure 51), indicating that the zinc is likely not biologically available and would be removed the turbidity treatment required prior to use as a drinking water source.

Figure 2. WSC Average Daily Flow Data for Peace River near Taylor (1984-2000)

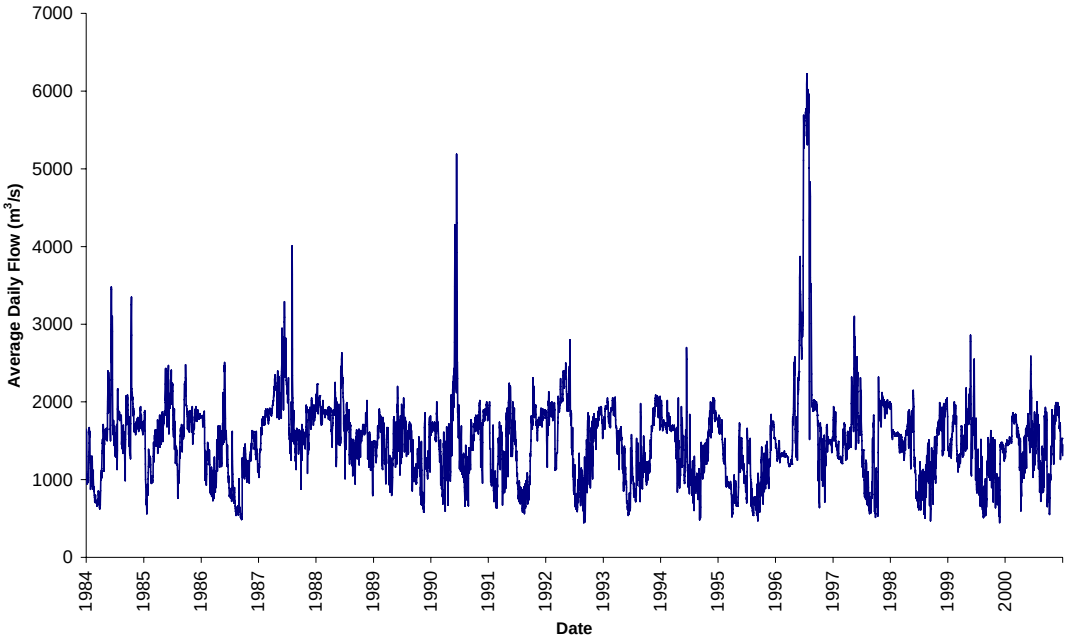

Figure 3. Peace River above Alces River - Alkalinity

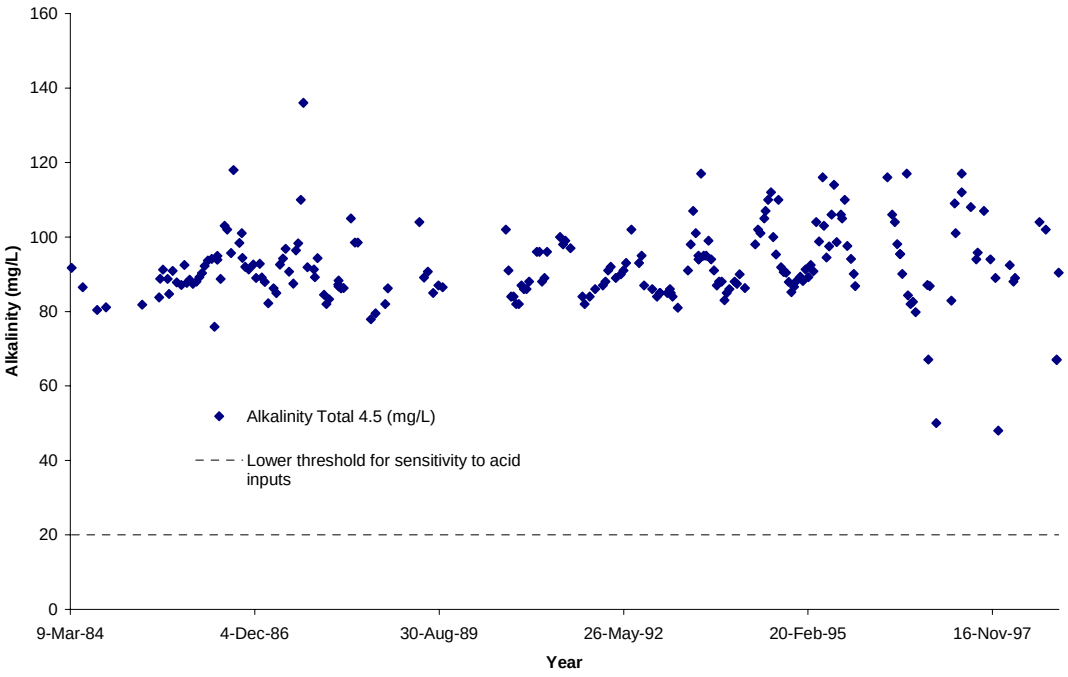

Figure 4. Peace River above Alces River - Aluminum, Total

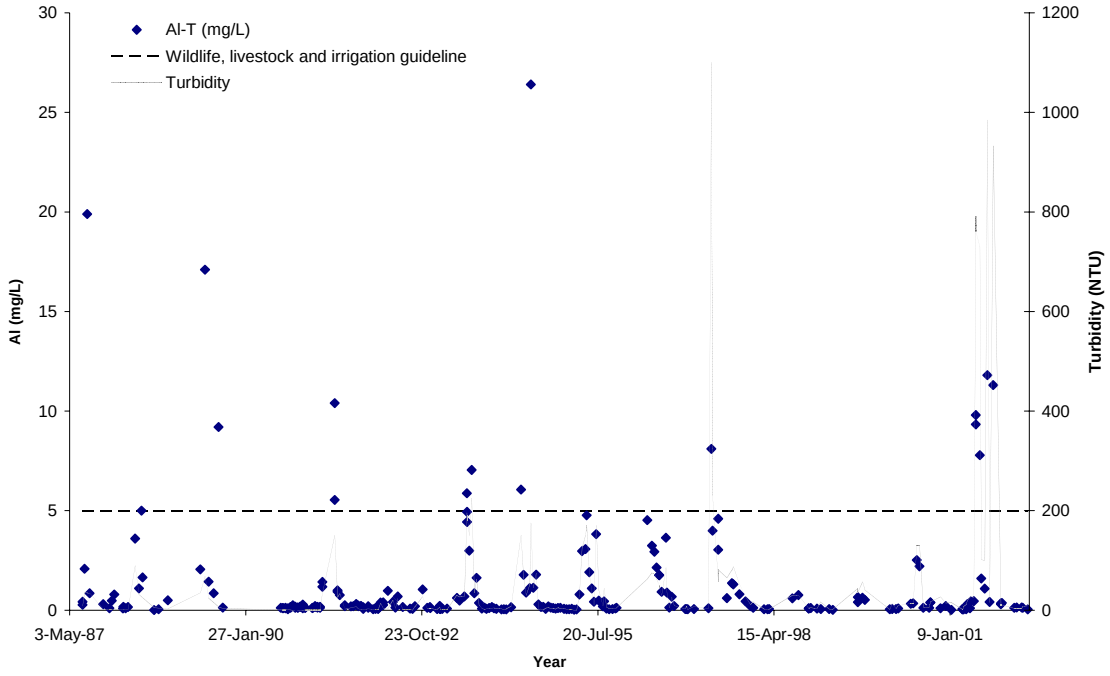

Figure 5. Peace River above Alces River - Arsenic, Total, Dissolved and Extractable

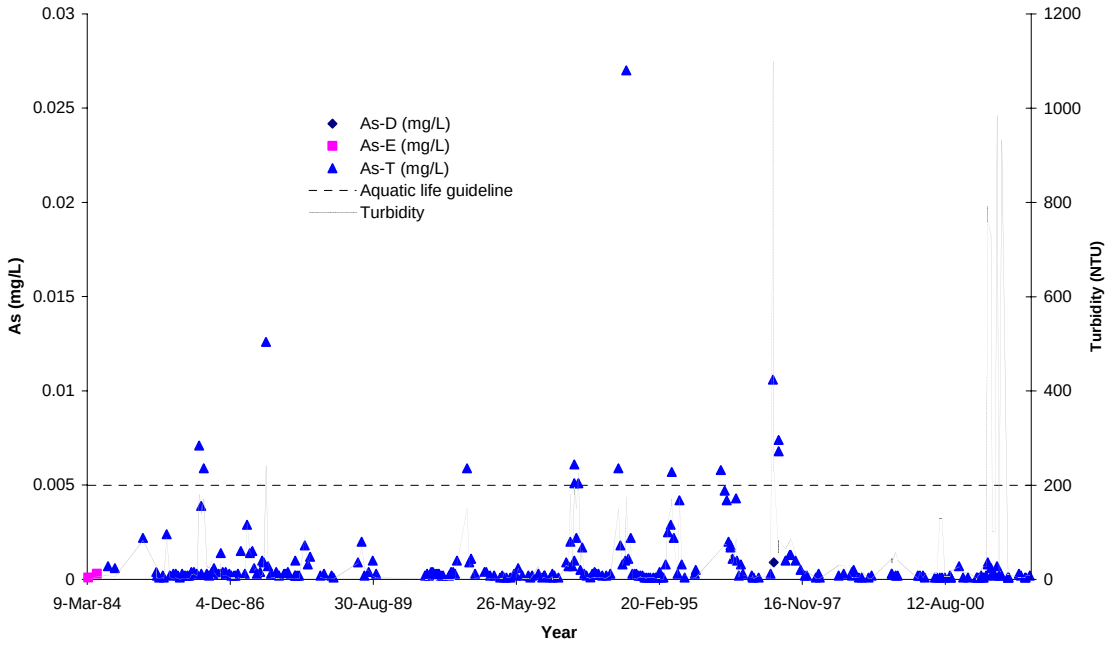

Figure 6. Peace River above Alces River - Barium, Total and Extractable

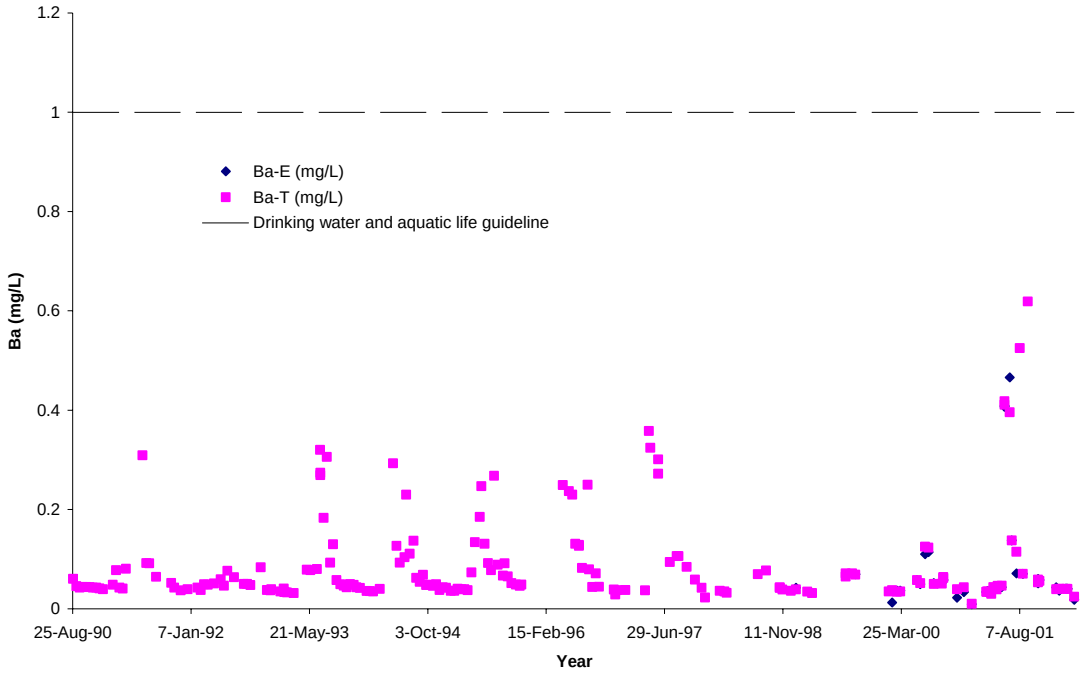

Figure 7. Peace River above Alces River - Beryllium, Total and Extractable

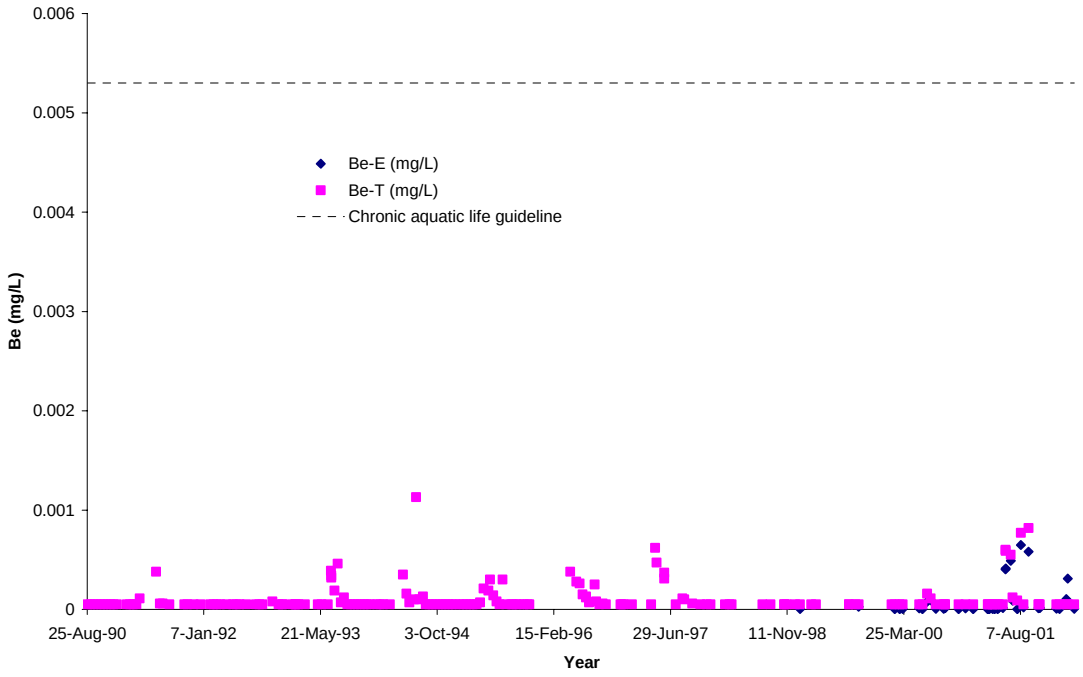

Figure 8. Peace River above Alces River - Boron, Extractable

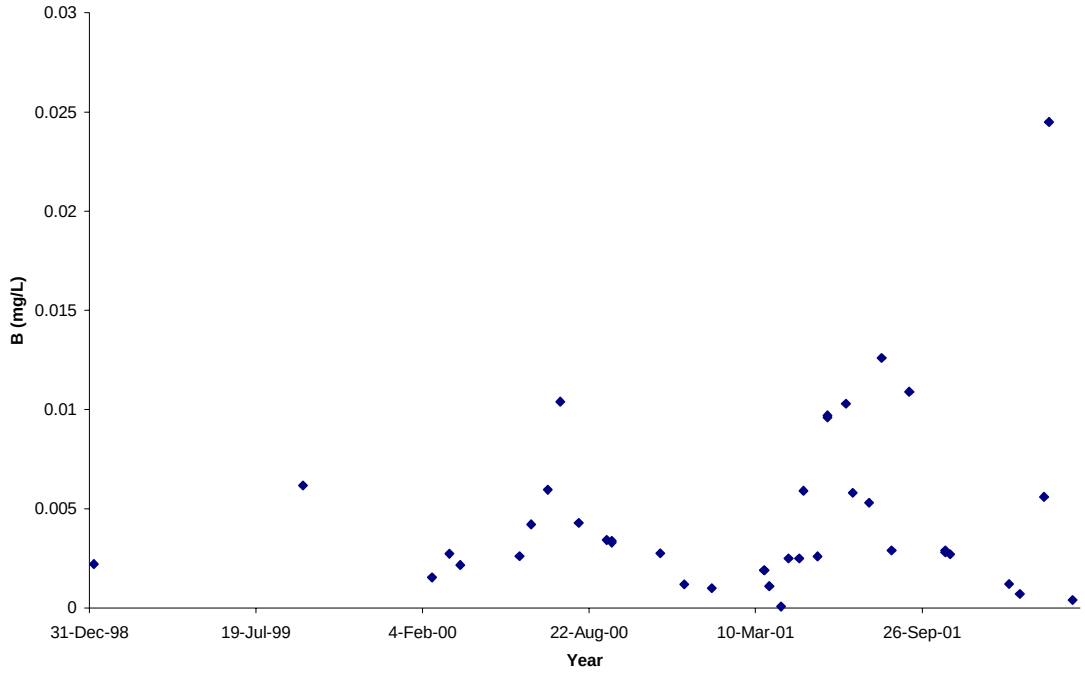

Figure 9. Peace River above Alces River - Bromide, Dissolved

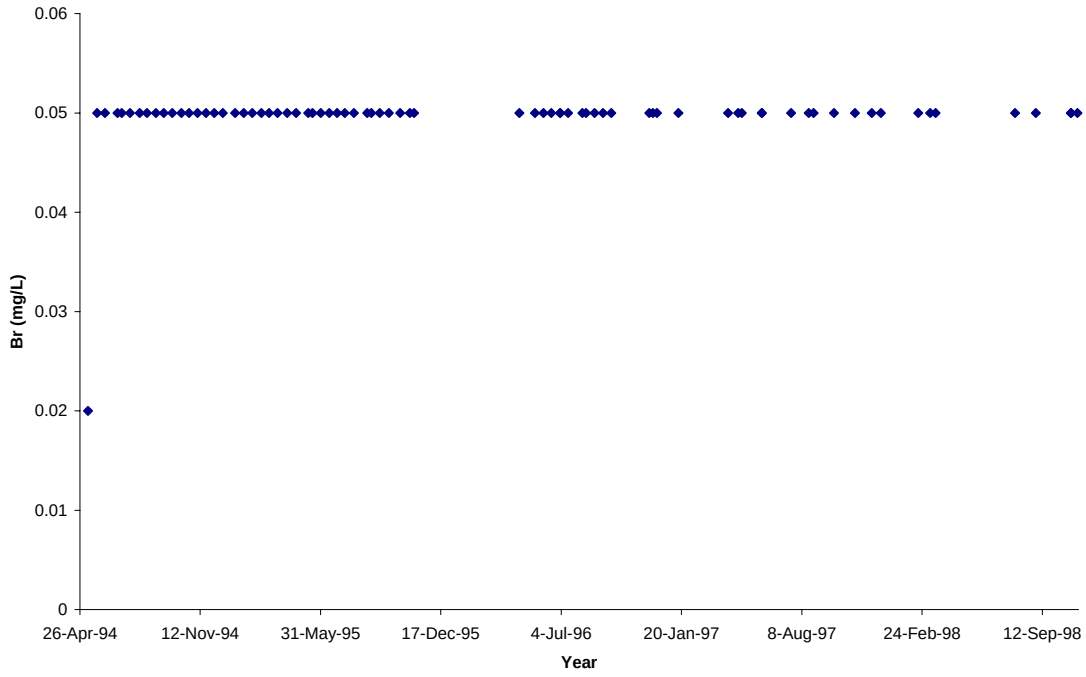

Figure 10. Peace River above Alces River - Cadmium, Total and Extractable

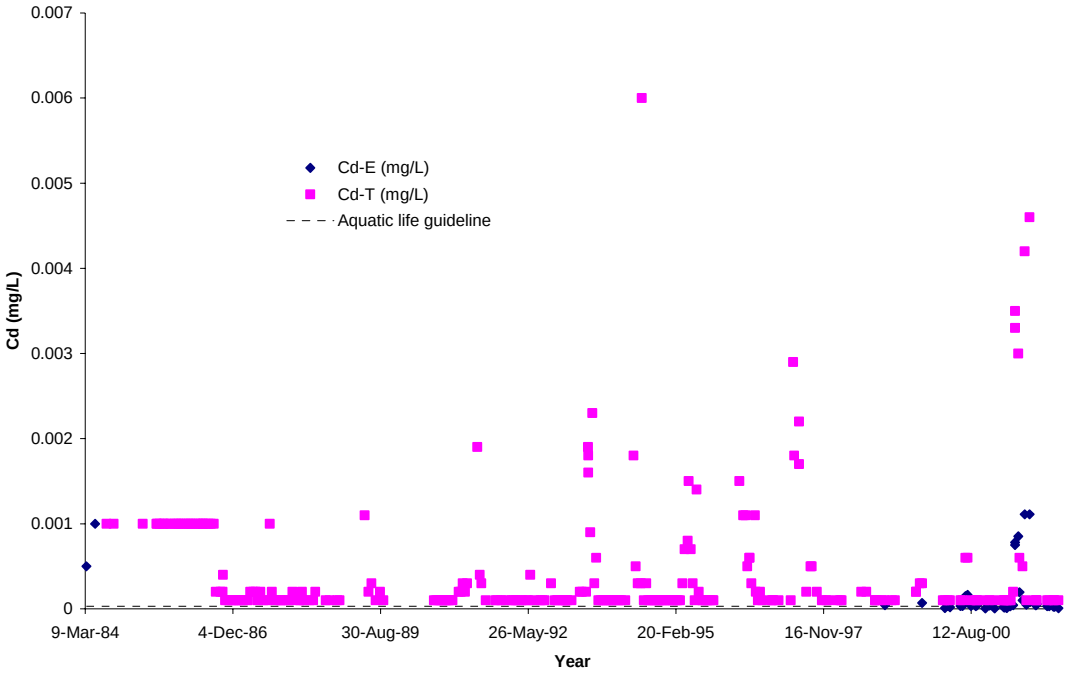

Figure 11. Peace River above Alces River - Calcium, Total, Dissolved and Extractable

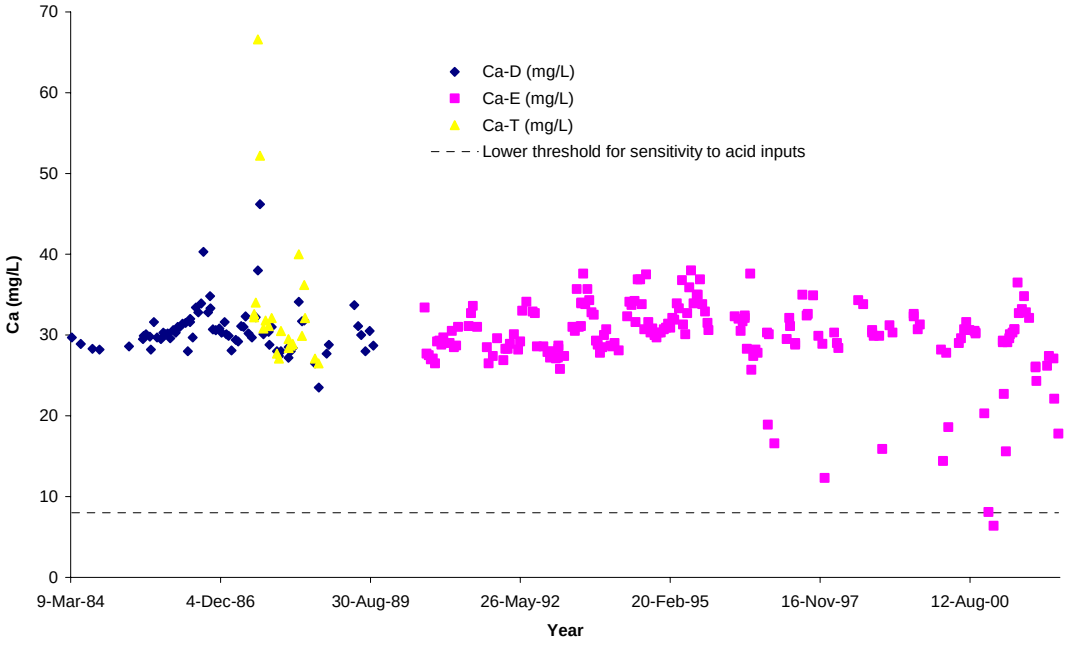

Figure 12. Peace River above Alces River - Carbon, Total and Total Dissolved

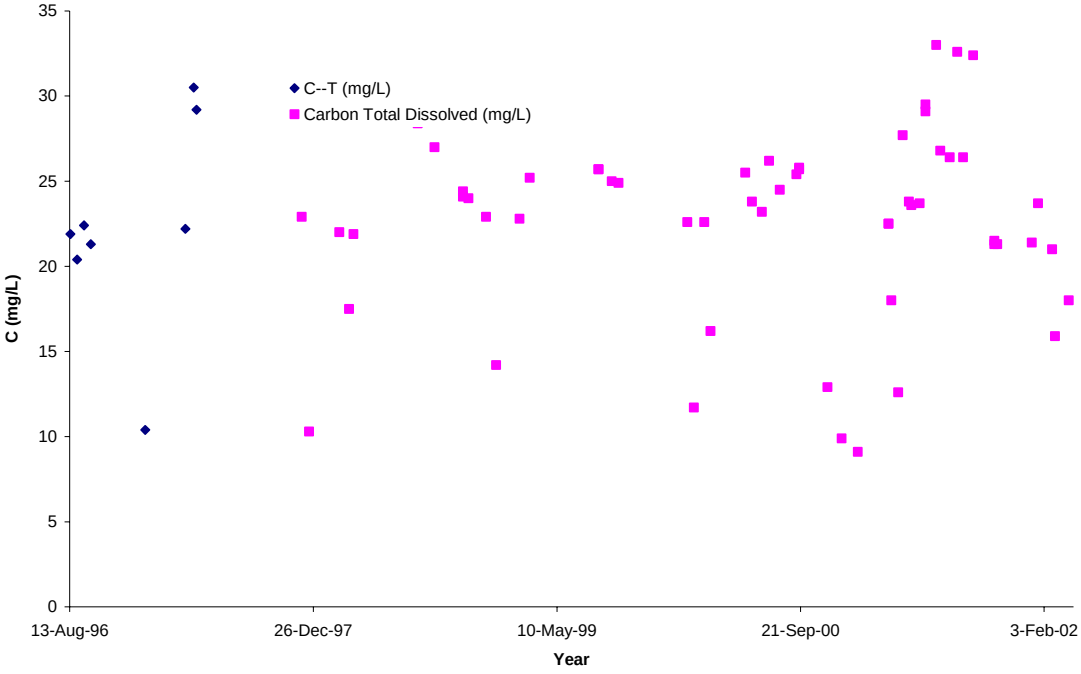

Figure 13. Peace River above Alces River - Carbon, Total and Dissolved Organic

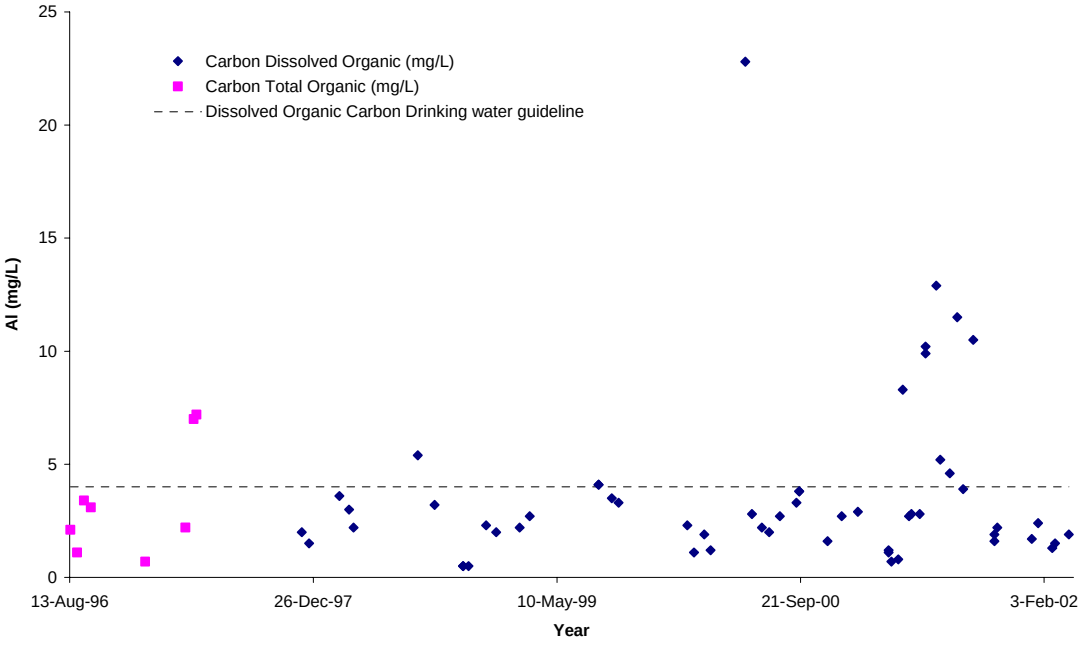

Figure 14. Peace River above Alces River - Chloride, Dissolved

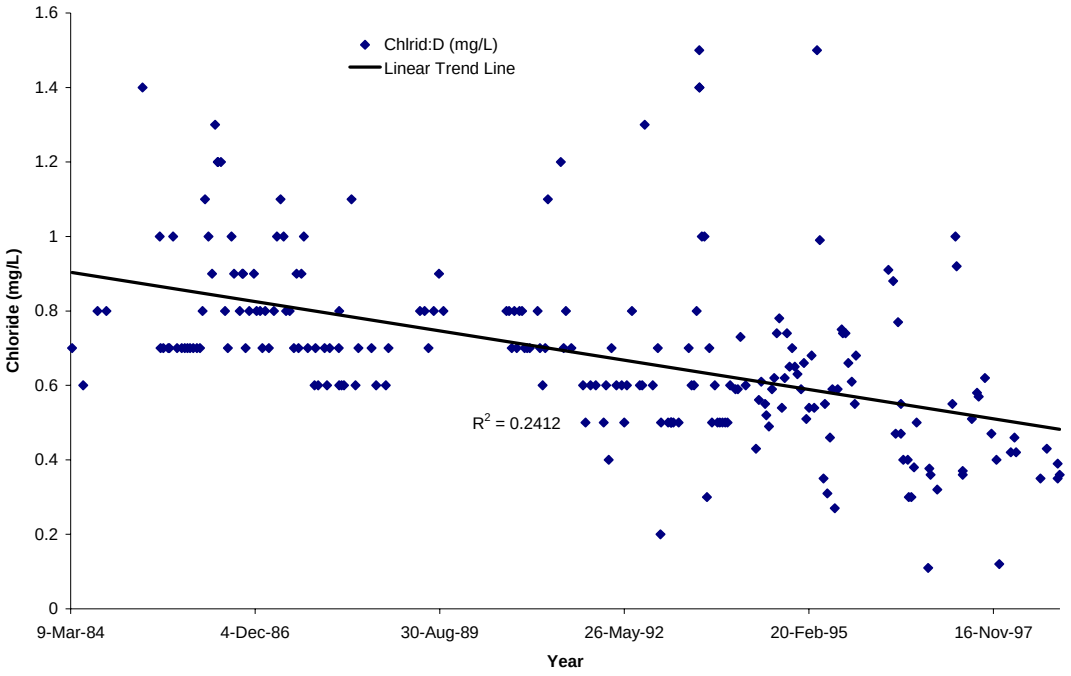

Figure 15. Peace River above Alces River - Chromium, Total and Extractable and Turbidity

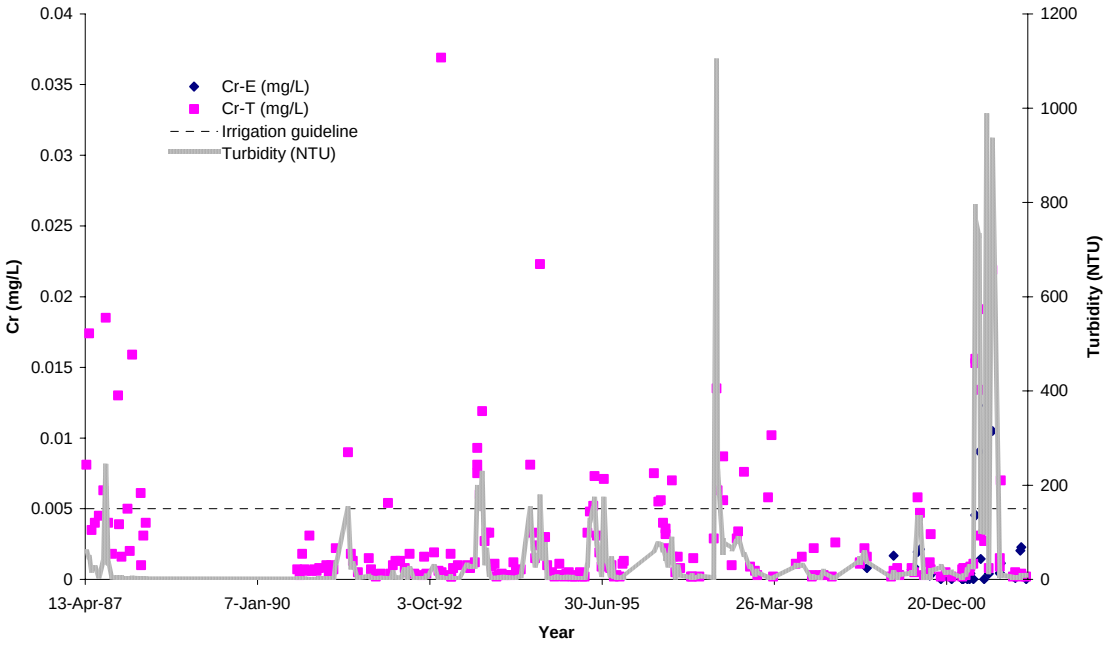

Figure 16. Peace River above Alces River - Cobalt, Total and Extractable and Turbidity

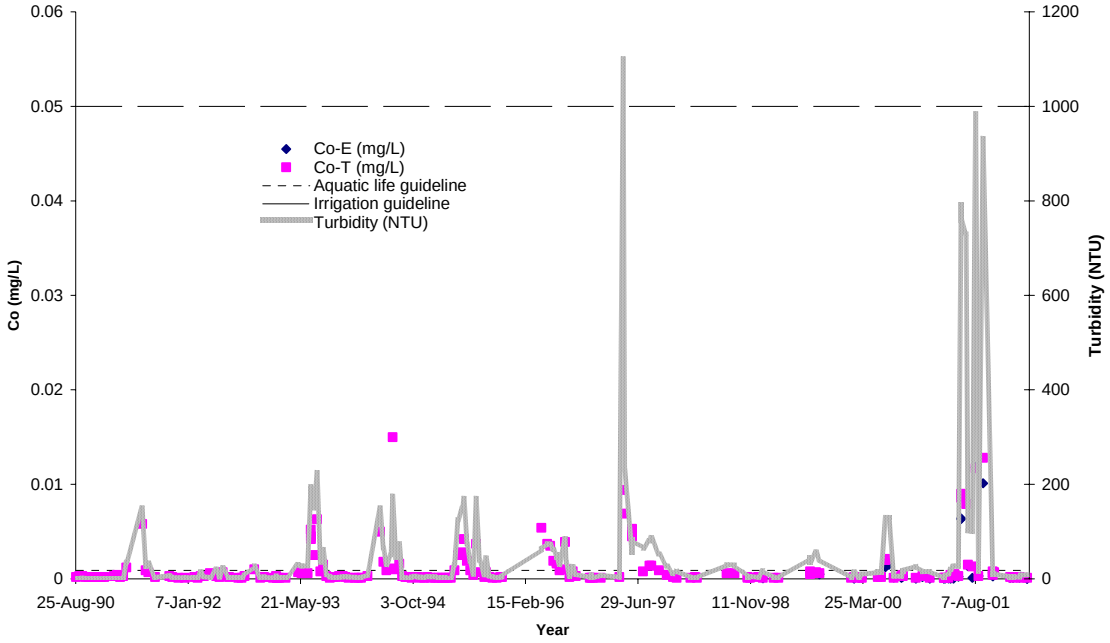

Figure 17. Peace River above Alces River - Coliforms, Fecal and *E. coli*

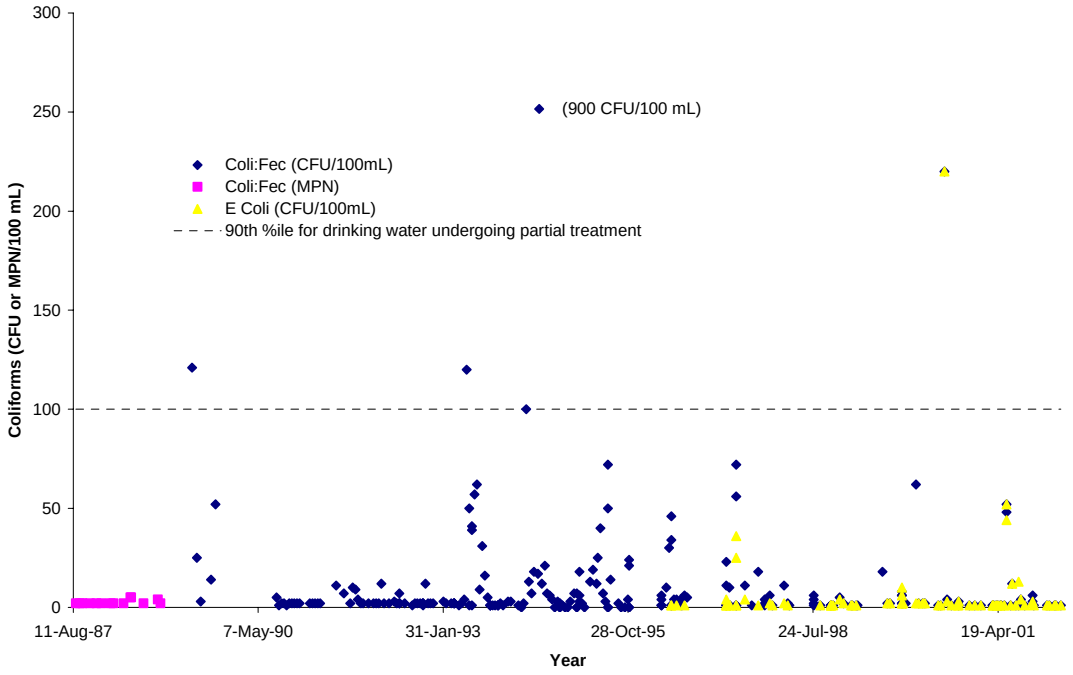

Figure 18. Peace River above Alces River - Colour

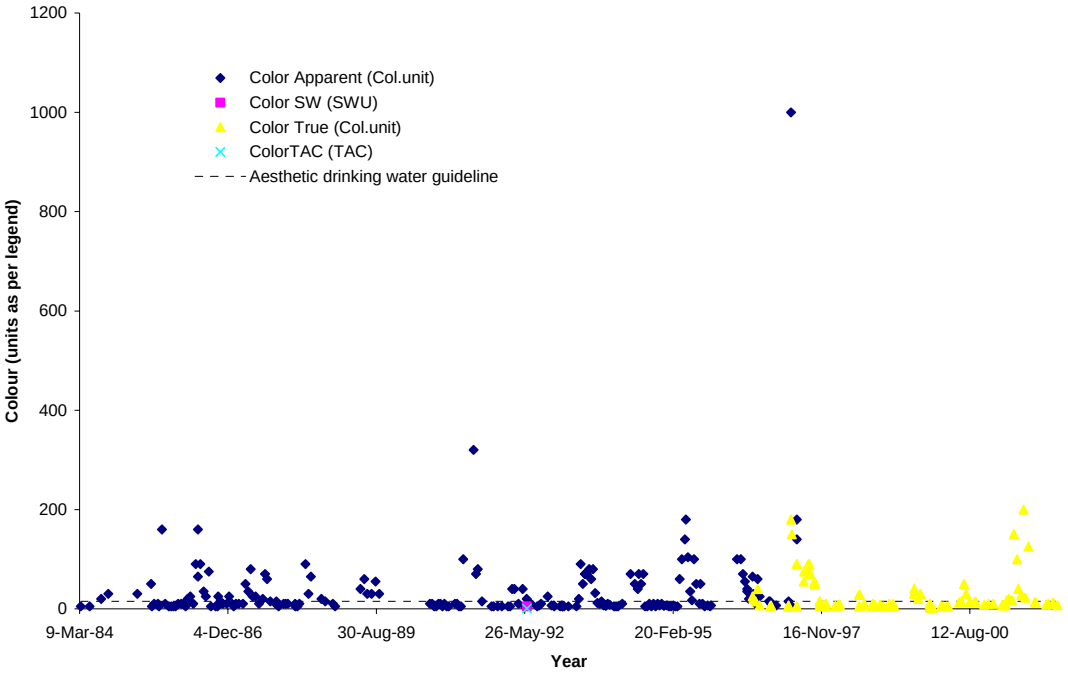

Figure 19. Peace River above Alces River - Conductivity, Specific

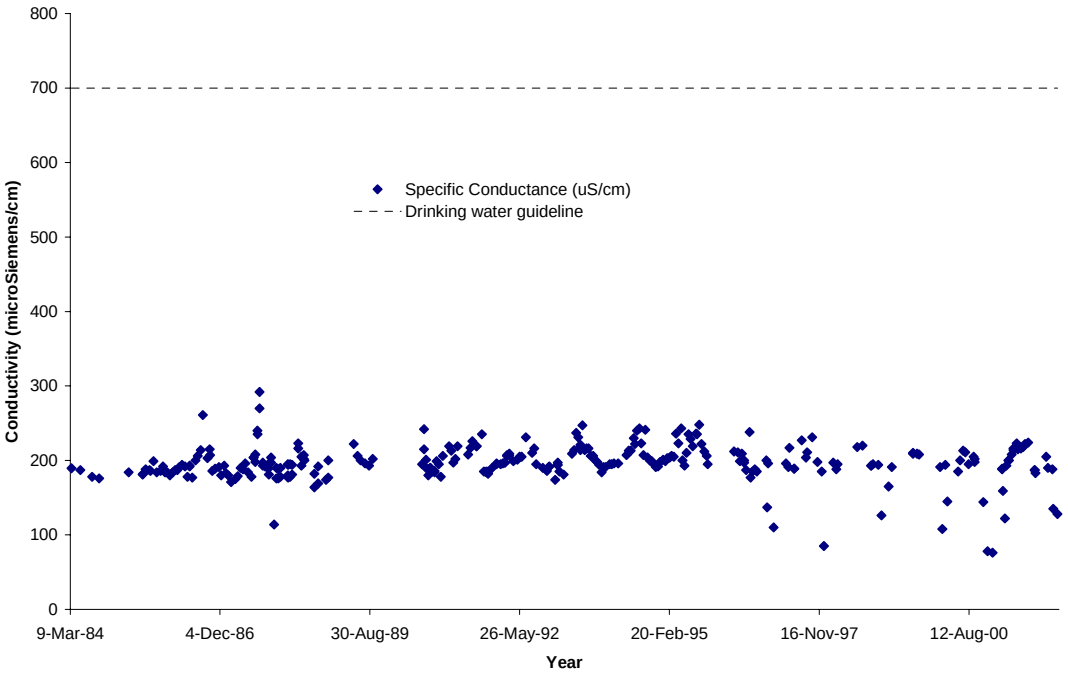

Figure 20. Peace River above Alces River - Copper, Total and Extractable

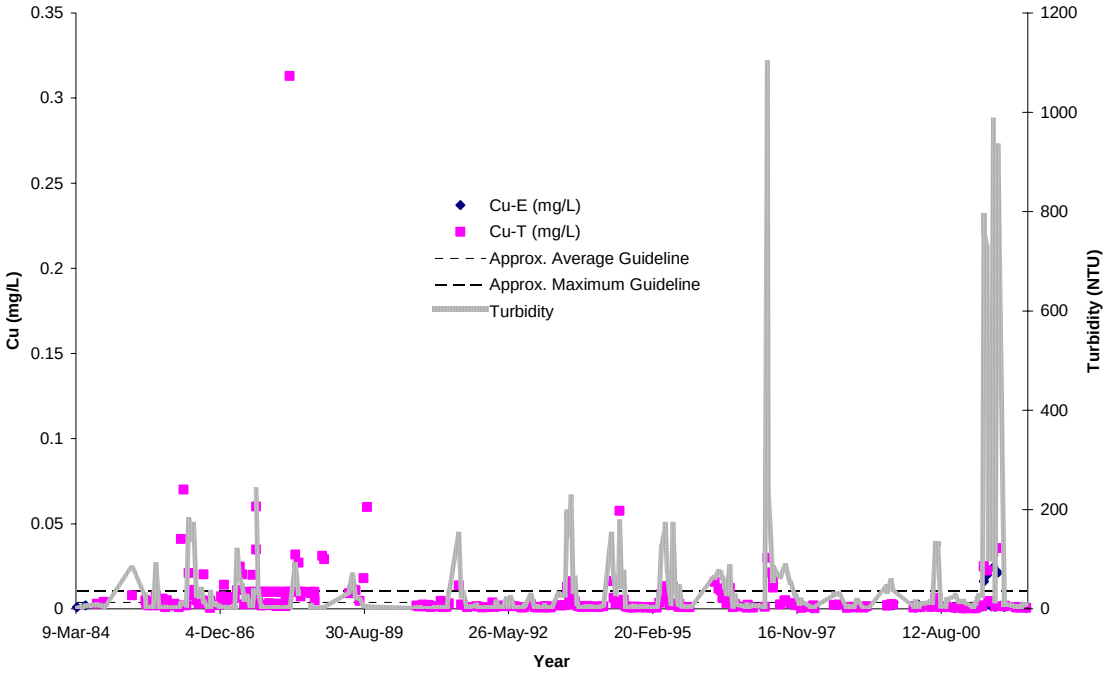

Figure 21. Peace River above Alces River - Cyanide, WAD and SAD + SCN

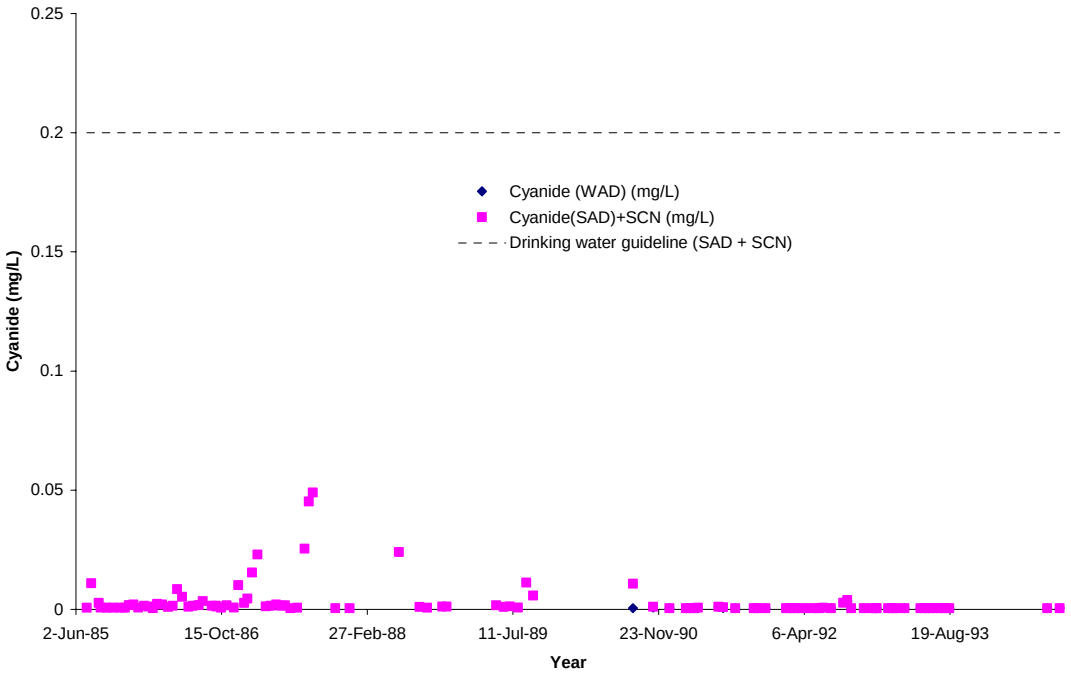

Figure 22. Peace River above Alces River - Fluoride, Dissolved and Total

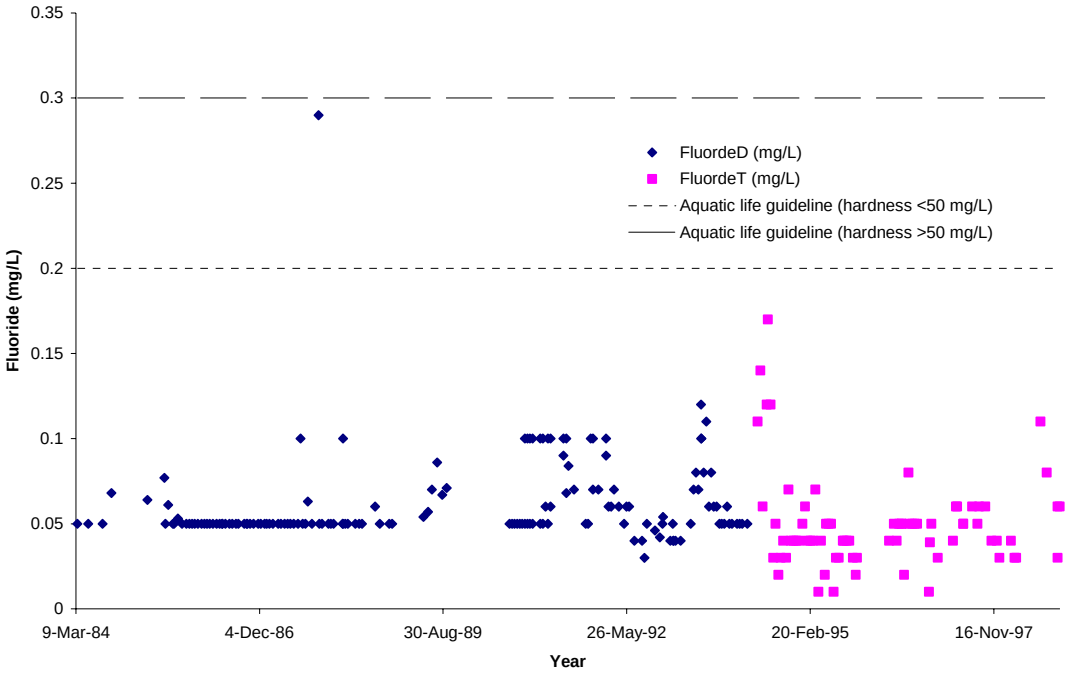

Figure 23. Peace River above Alces River - Gallium, Extractable

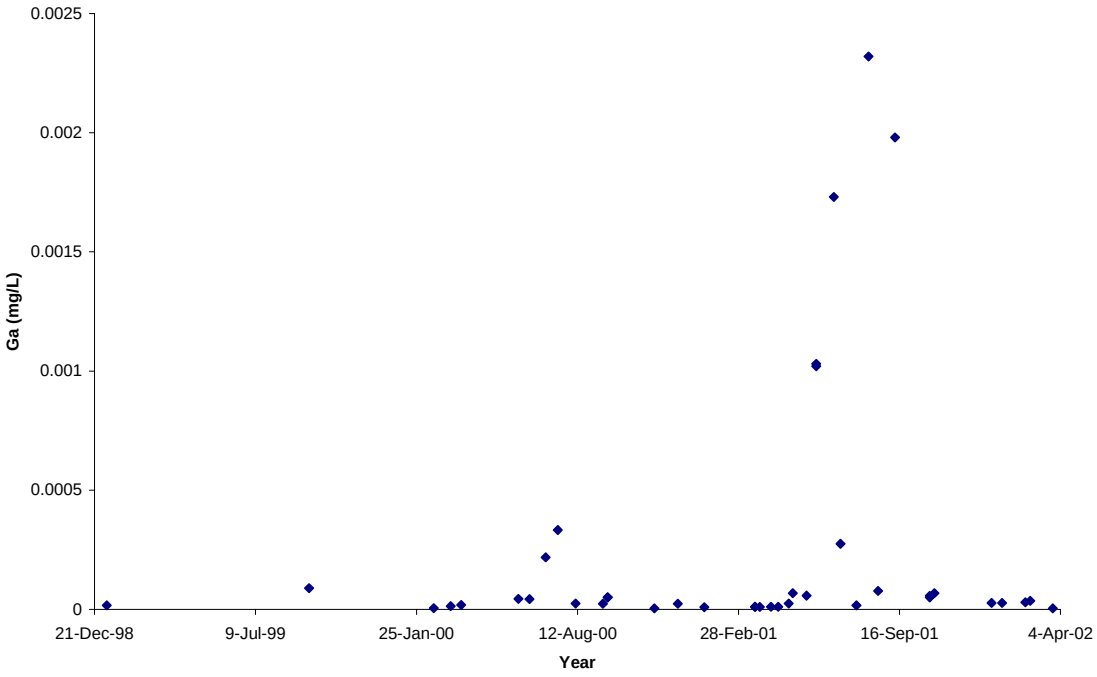

Figure 24. Peace River above Alces River - Hardness, Total Dissolved and Extractable

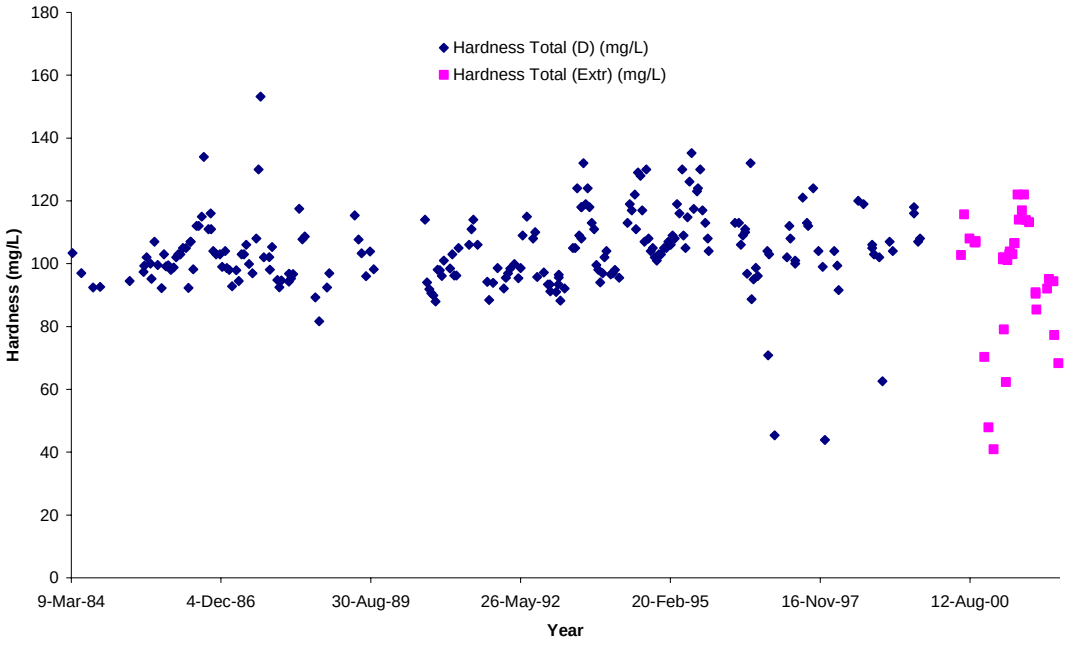

Figure 25. Peace River above Alces River - Iron, Total and Extractable

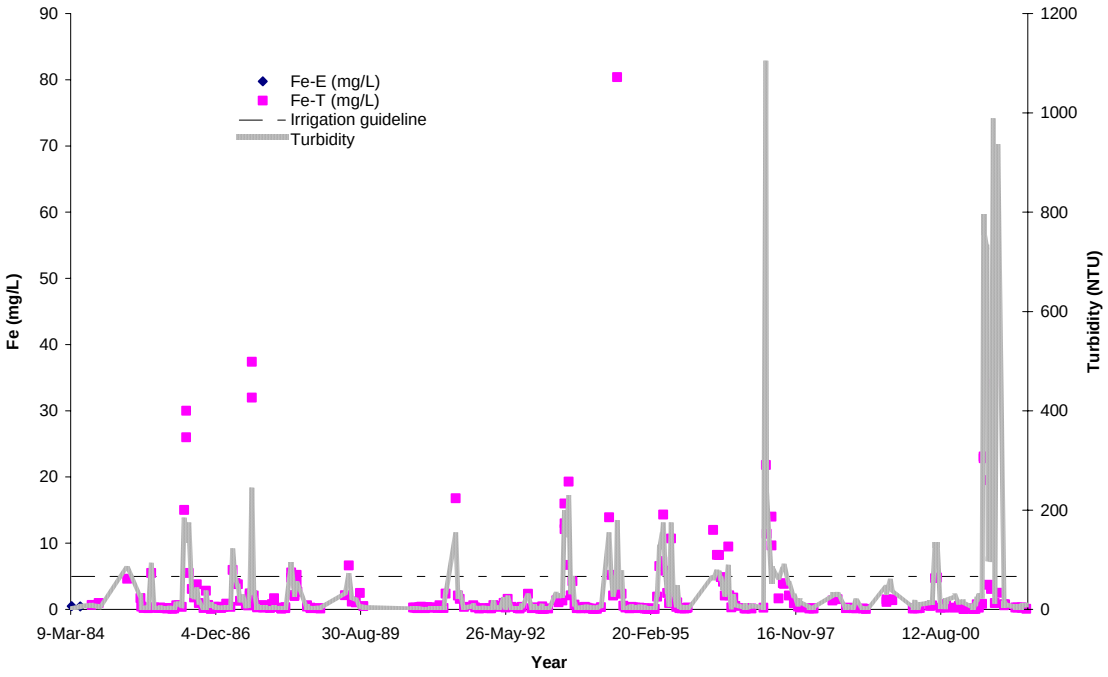

Figure 26. Peace River above Alces River - Lanthanum, Extractable

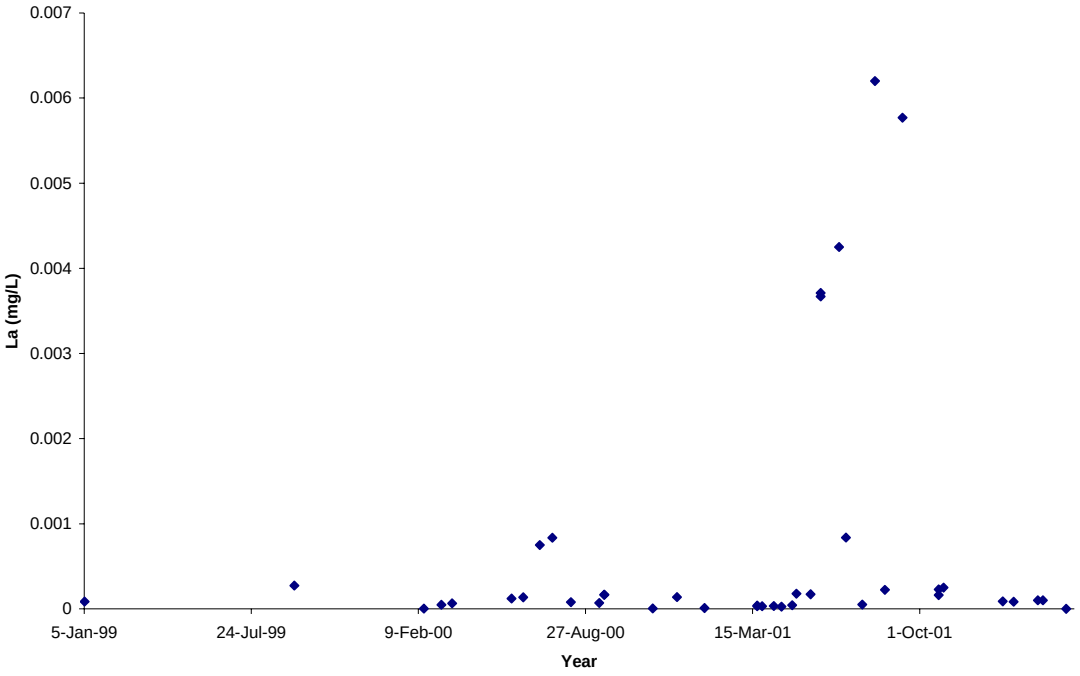

Figure 27. Peace River above Alces River - Lead, Total and Extractable

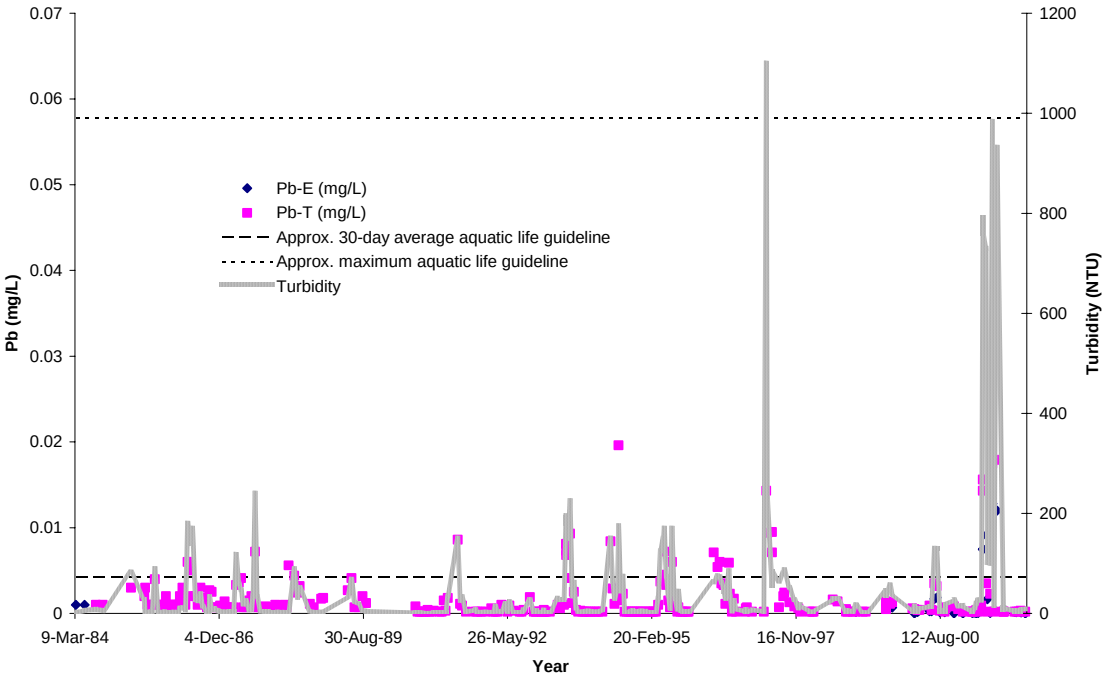

Figure 28. Peace River above Alces River - Lithium, Total and Extractable

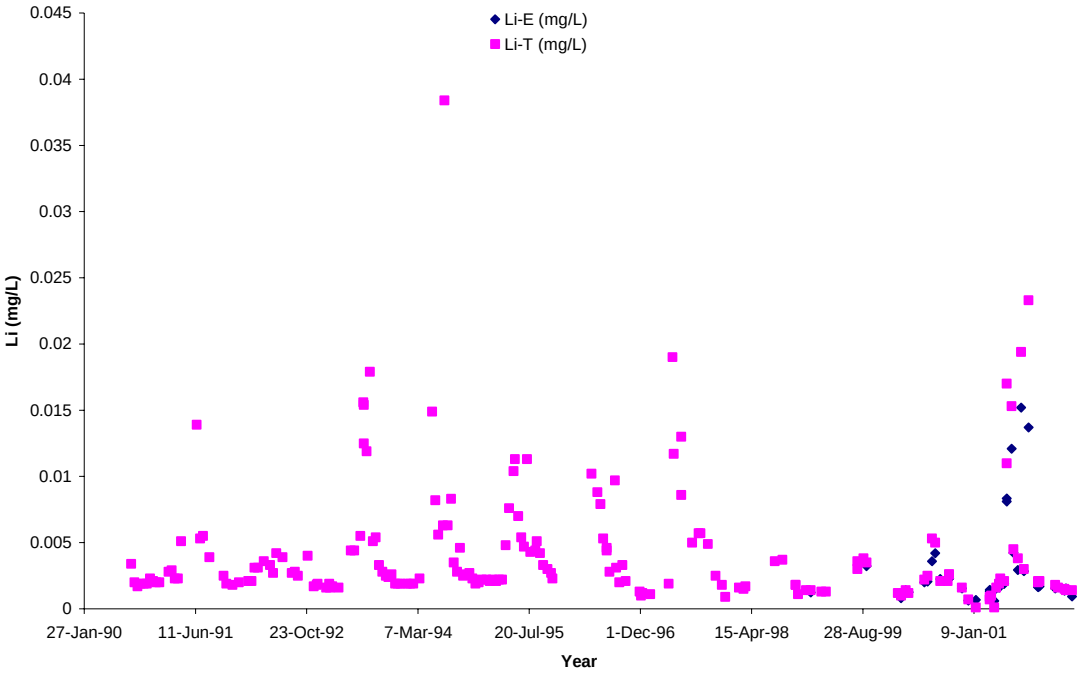

Figure 29. Peace River above Alces River - Magnesium, Total, Dissolved and Extractable

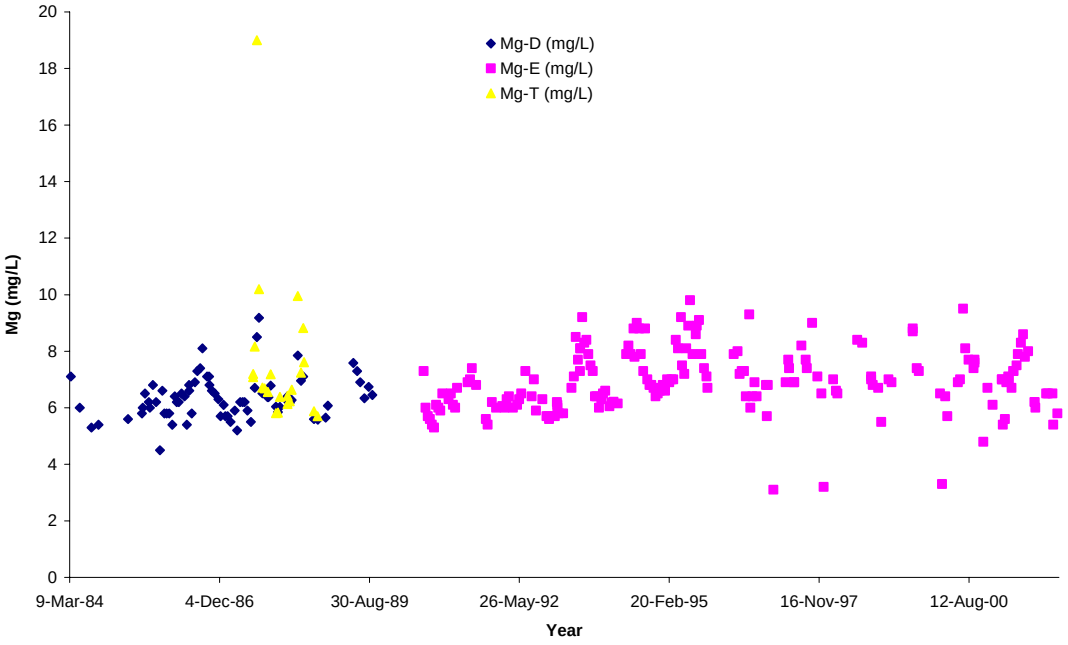

Figure 30. Peace River above Alces River - Manganese, Total and Extractable and Turbidity

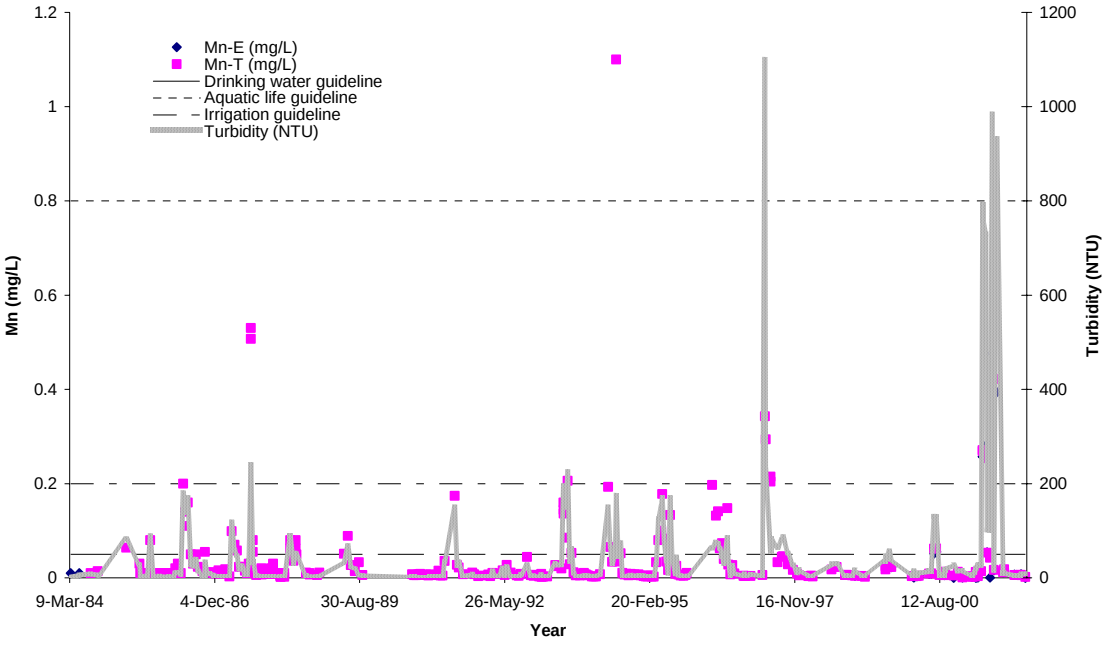

Figure 31. Peace River above Alces River - Molybdenum, Total

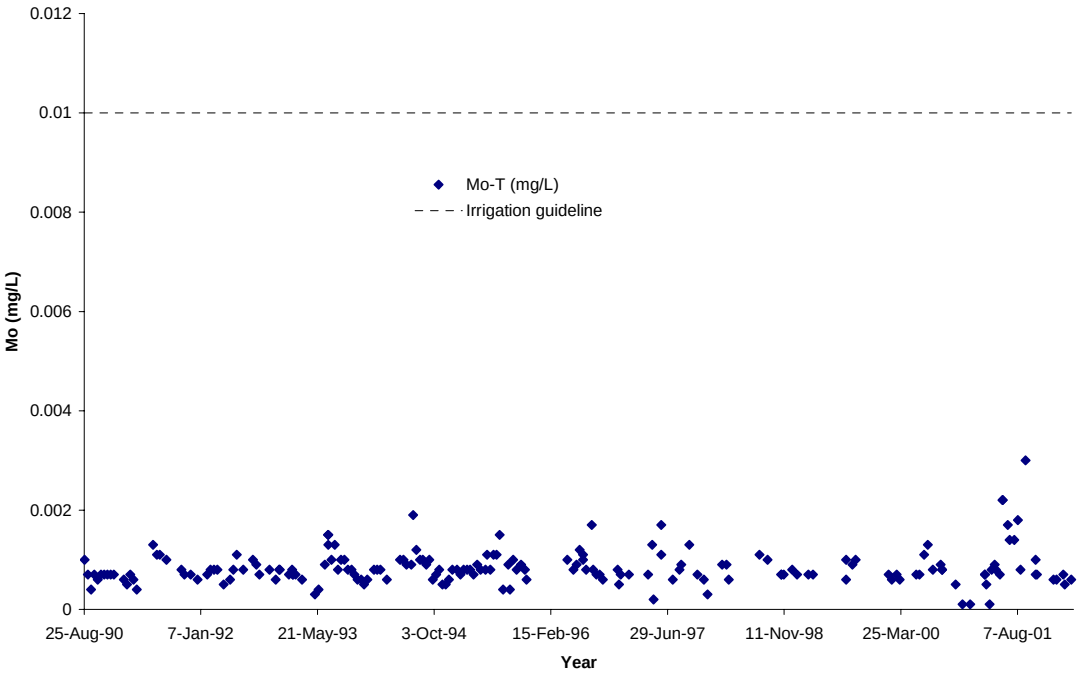

Figure 32. Peace River above Alces River - Nickel, Total and Extractable

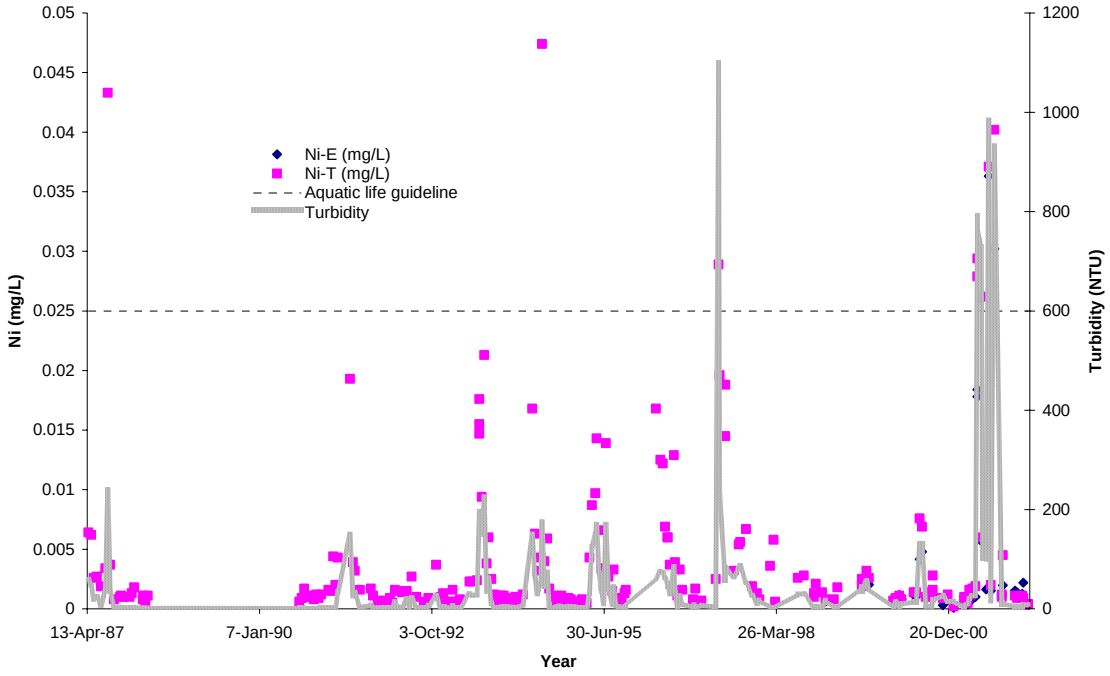

Figure 33. Peace River above Alces River - Nitrogen, Kjeldahl

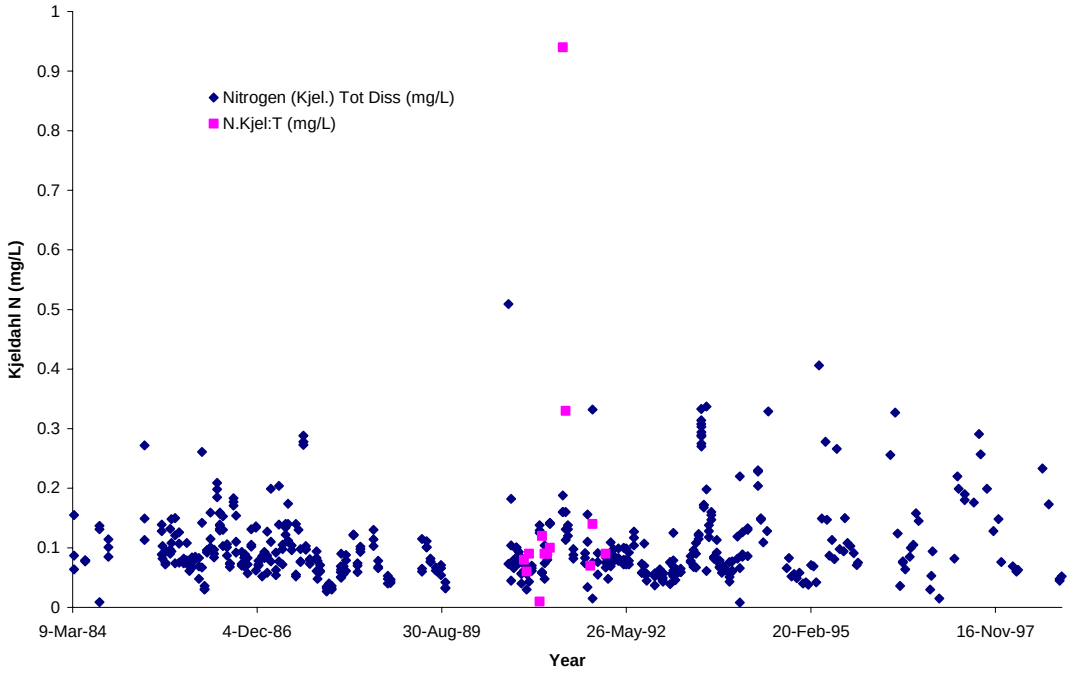

Figure 34. Peace River above Alces River - Nitrate, Dissolved and/or Nitrite, Dissolved

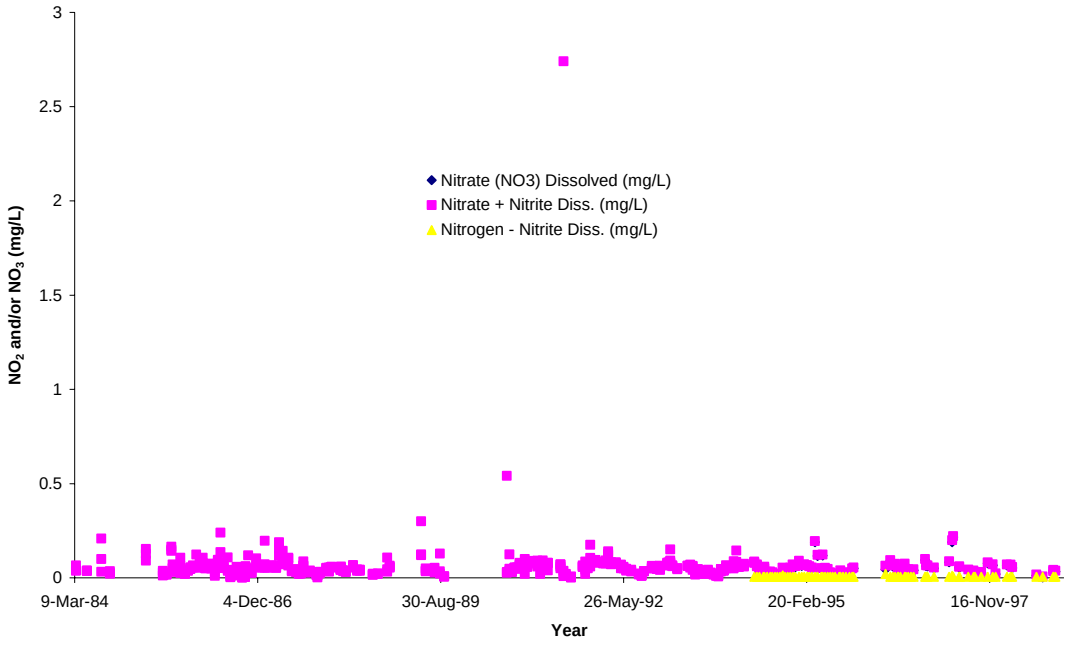

Figure 35. Peace River above Alces River - Nitrogen, Total

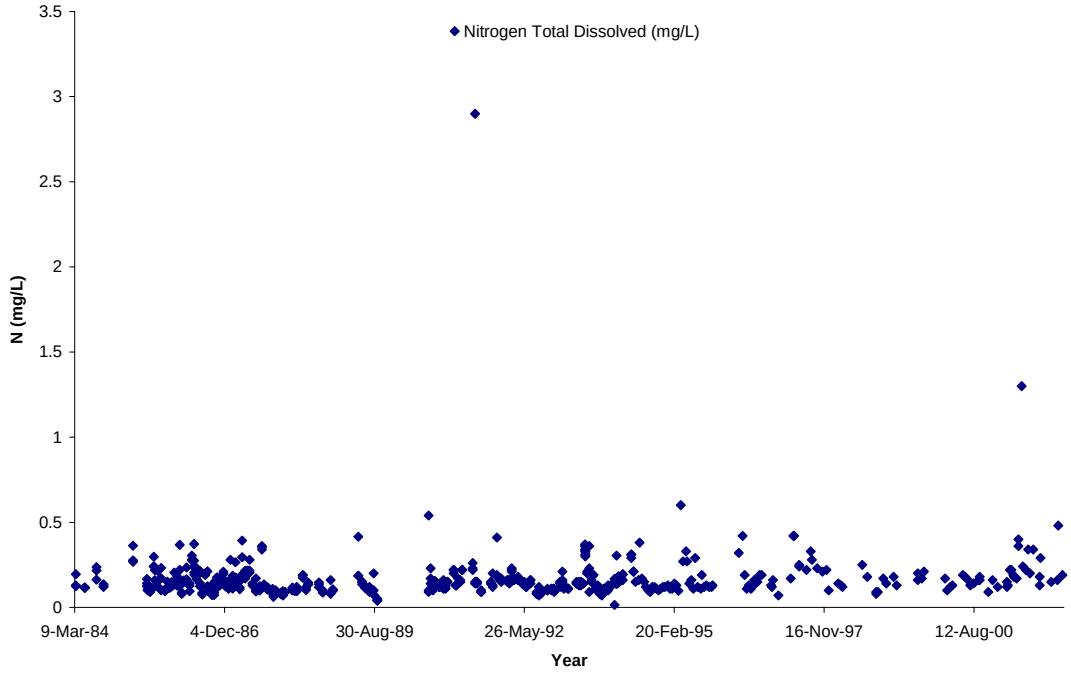

Figure 36. Peace River above Alces River - pH

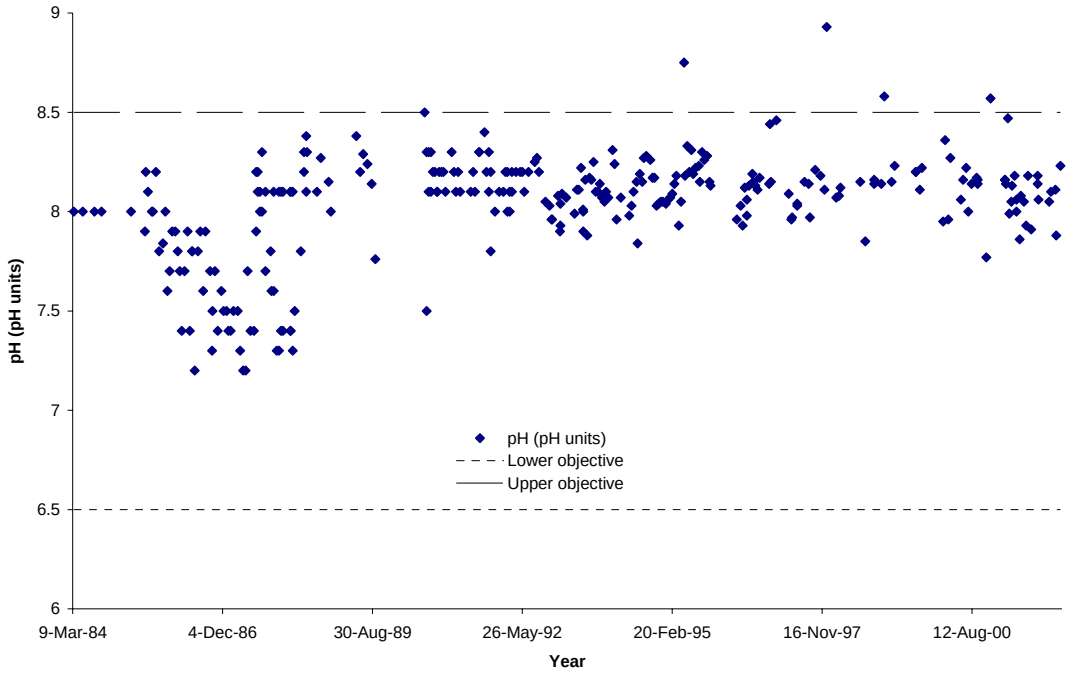

Figure 37. Peace River above Alces River - Phosphorus, Total and Dissolved

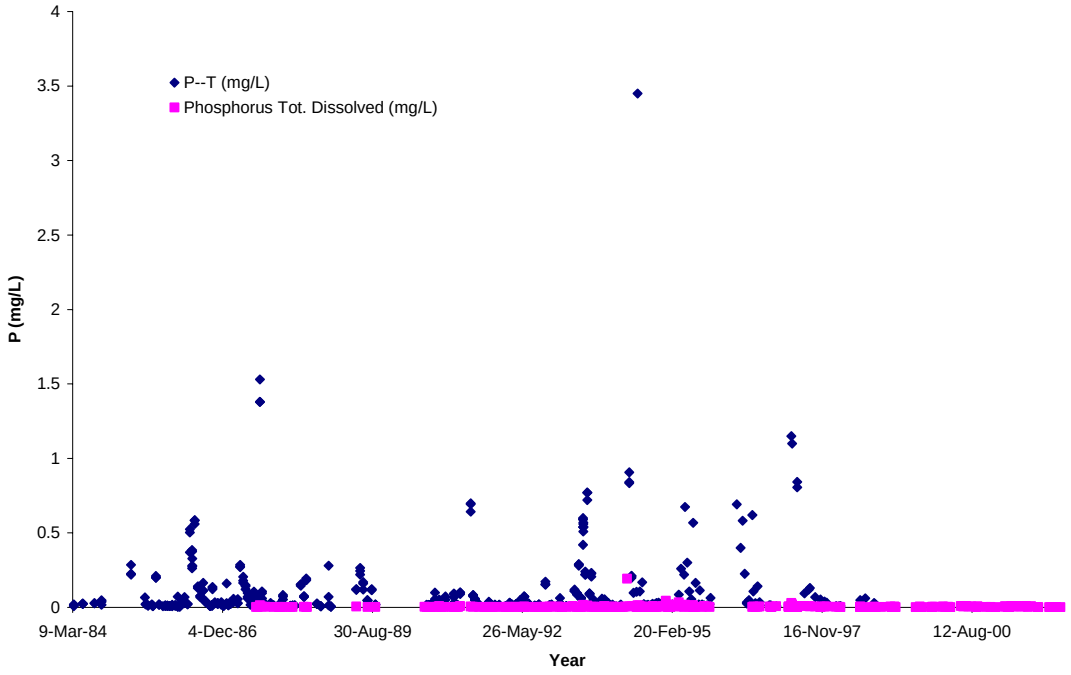

Figure 38. Peace River above Alces River - Potassium, Dissolved and Extractable

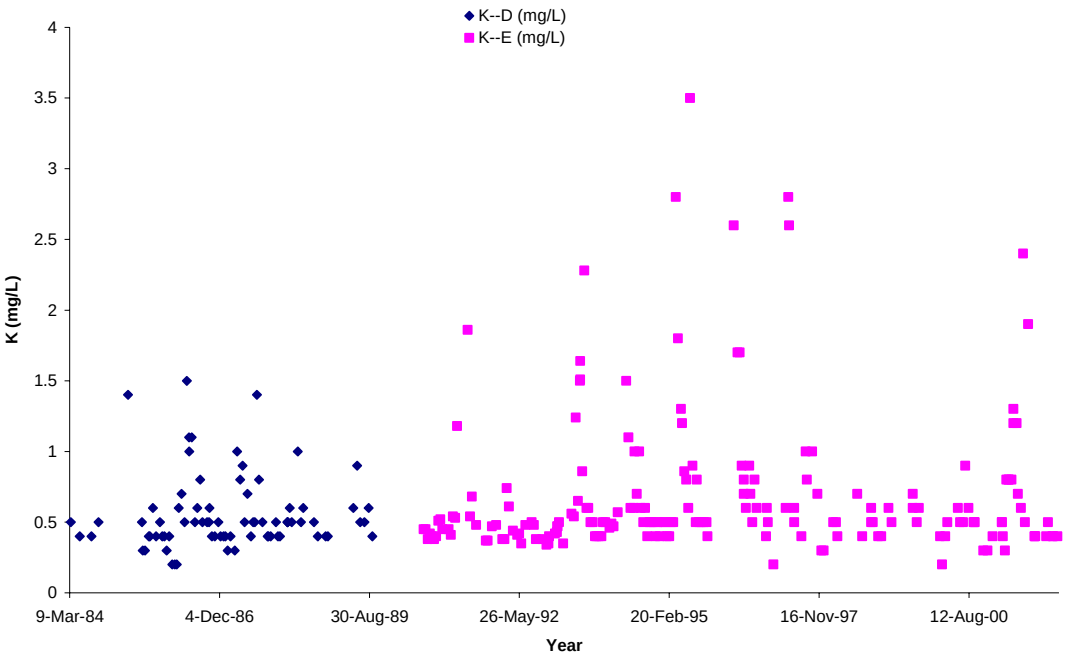

Figure 39. Peace River above Alces River - Residue, Filterable

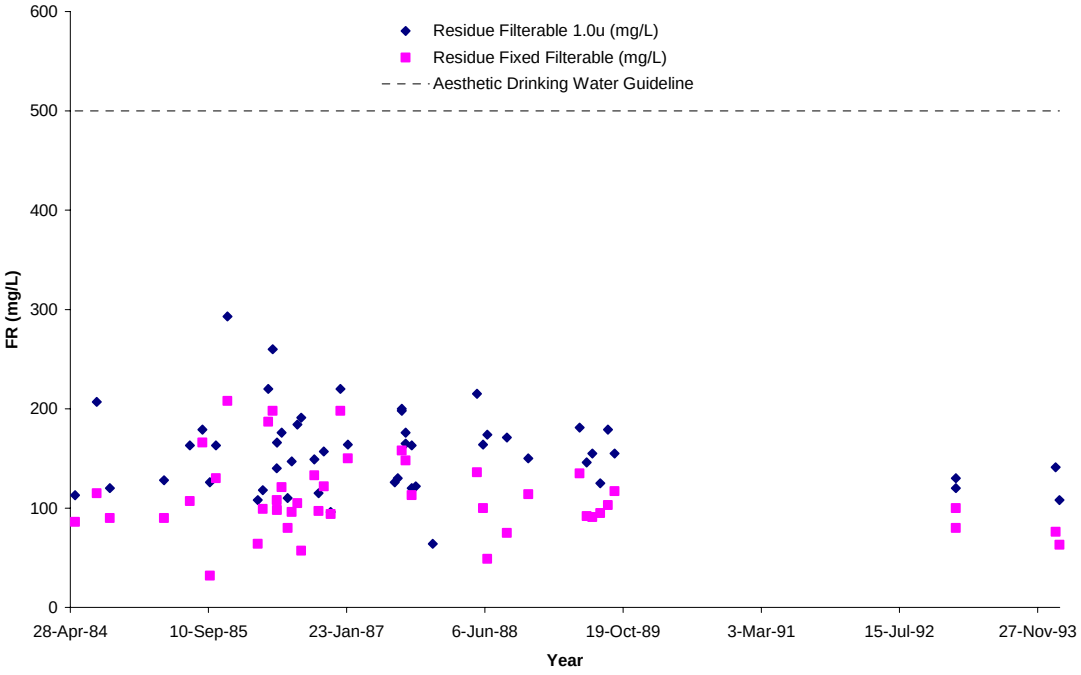

Figure 40. Peace River above Alces River - Residue, Non-Filterable and Average Daily Flow

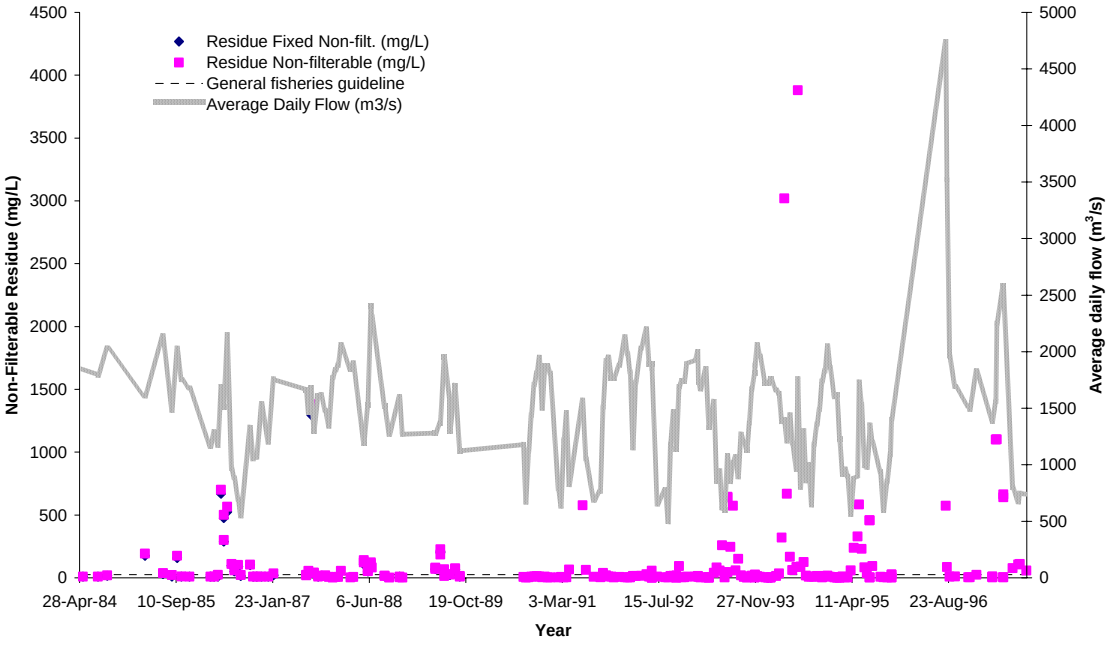

Figure 41. Peace River above Alces River - Rubidium, Extractable

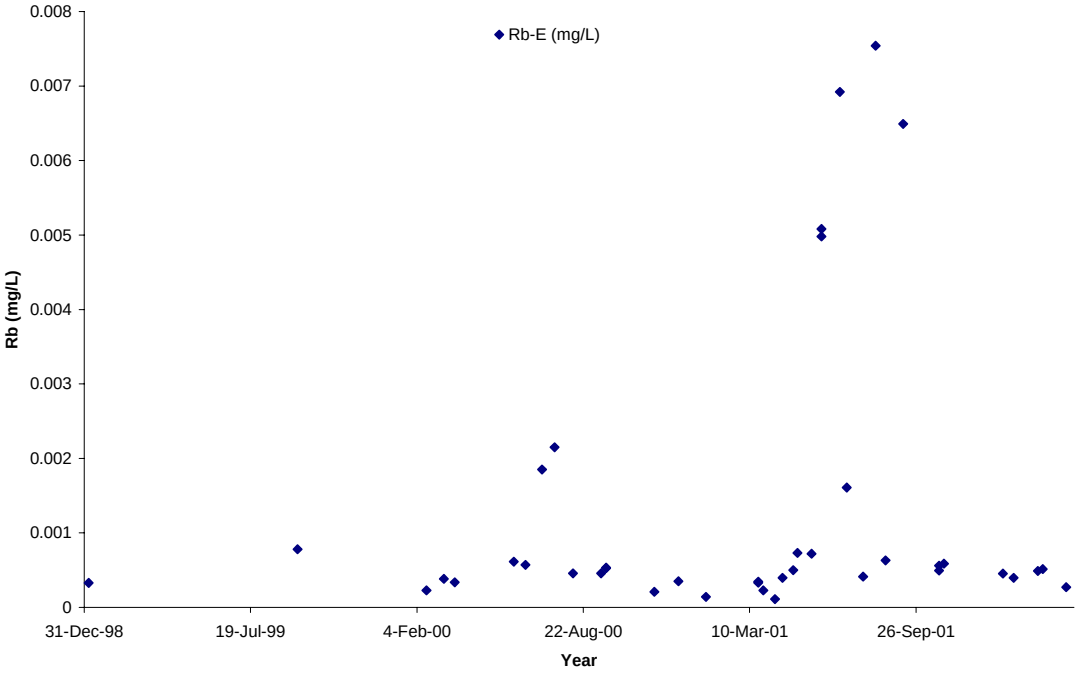

Figure 42. Peace River above Alces River - Selenium, Total, Dissolved and Extractable

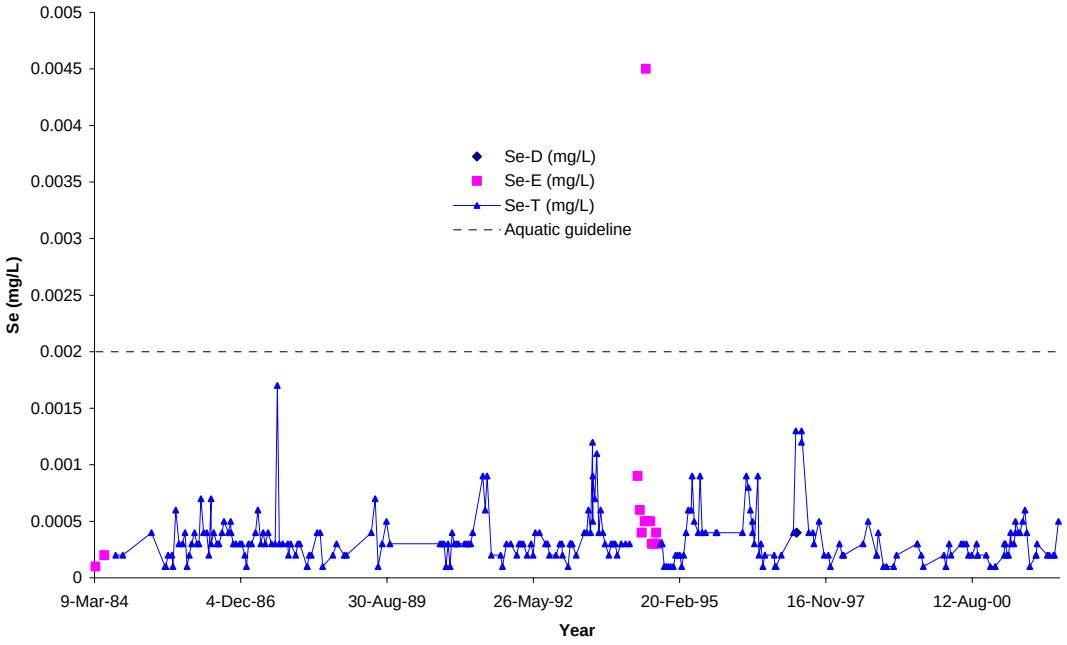

Figure 43. Peace River above Alces River - Silica, Dissolved and Silicon, Dissolved and Extractable

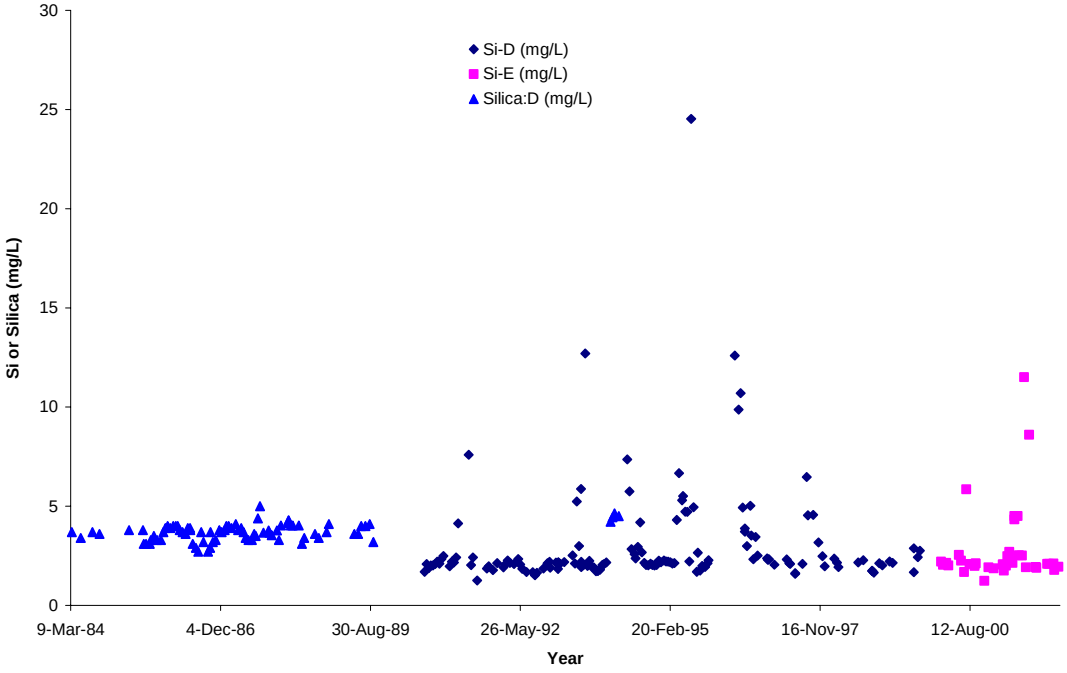

Figure 44. Peace River above Alces River - Silver, Total and Extractable

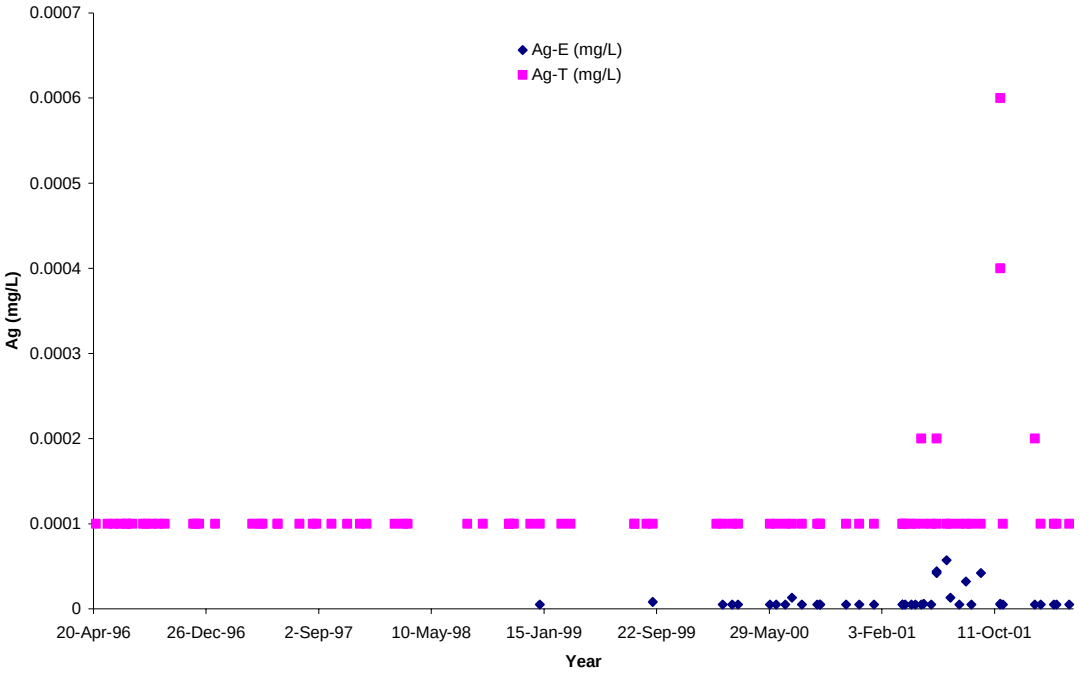

Figure 45. Peace River above Alces River - Sodium, Dissolved and Extractable

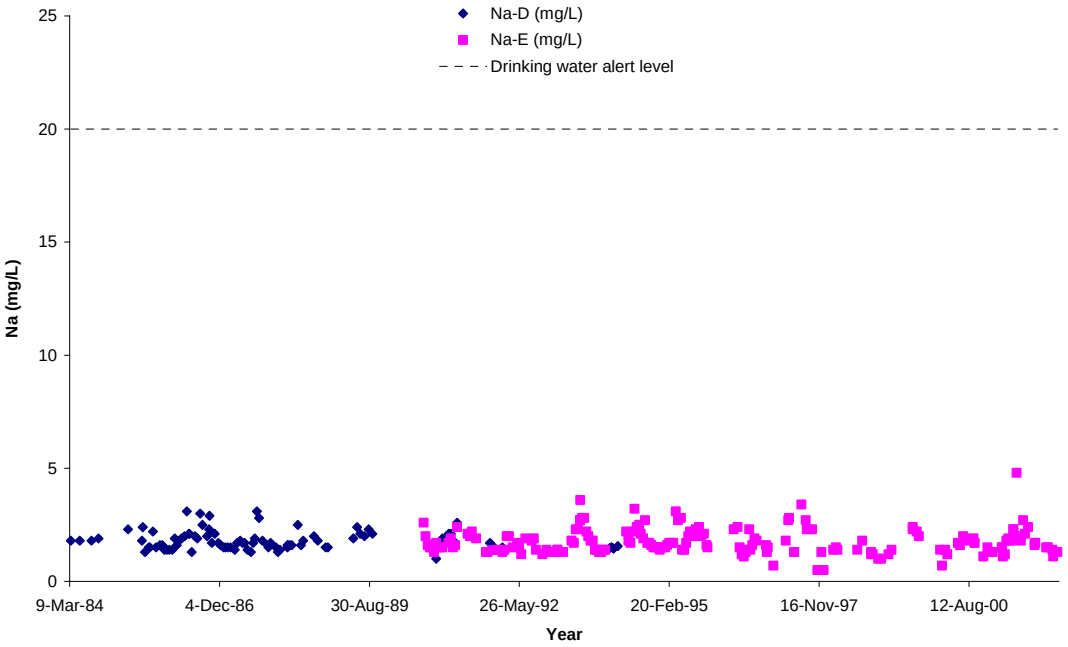

Figure 46. Peace River above Alces River - Strontium, Total and Extractable

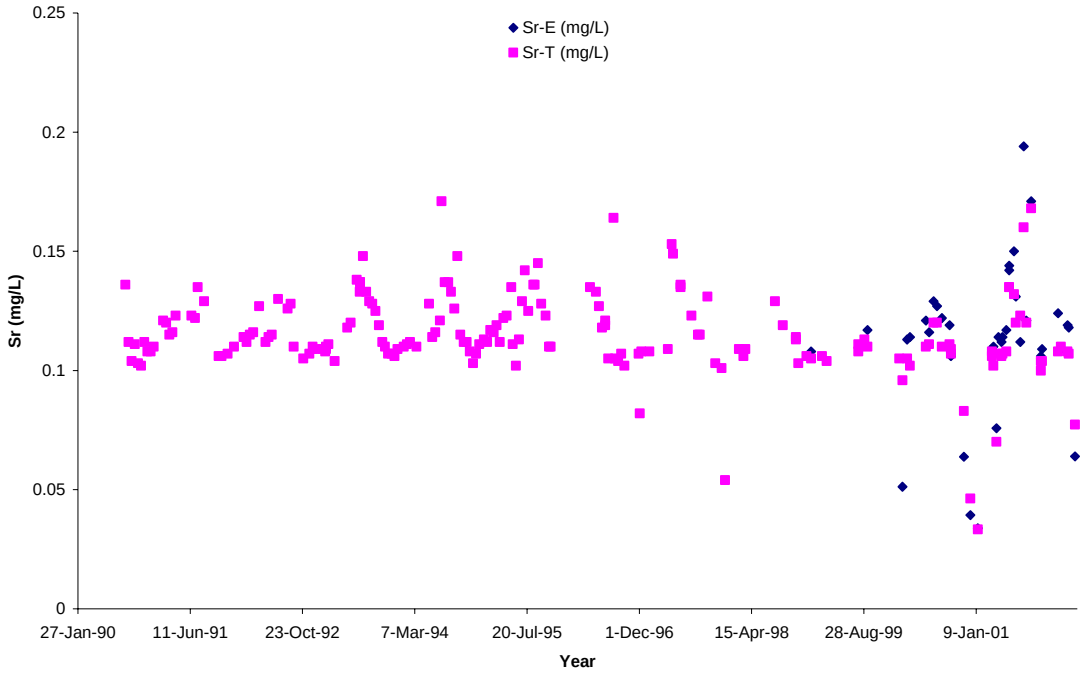

Figure 47. Peace River above Alces River - Sulphate, Dissolved

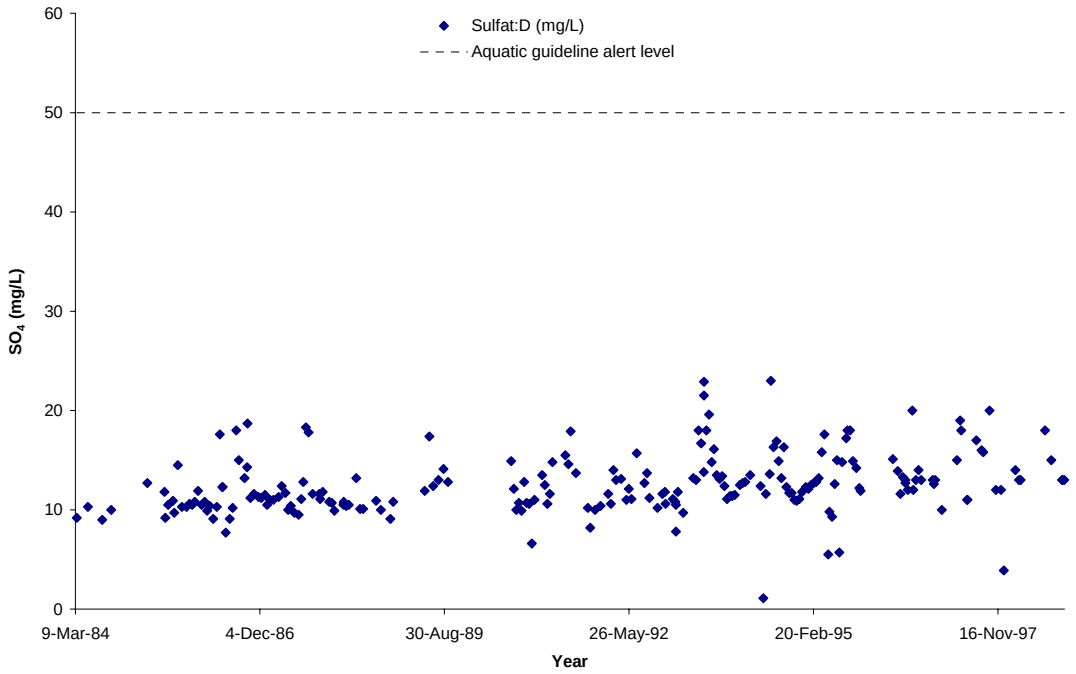

Figure 48. Peace River above Alces River - Temperature, Water

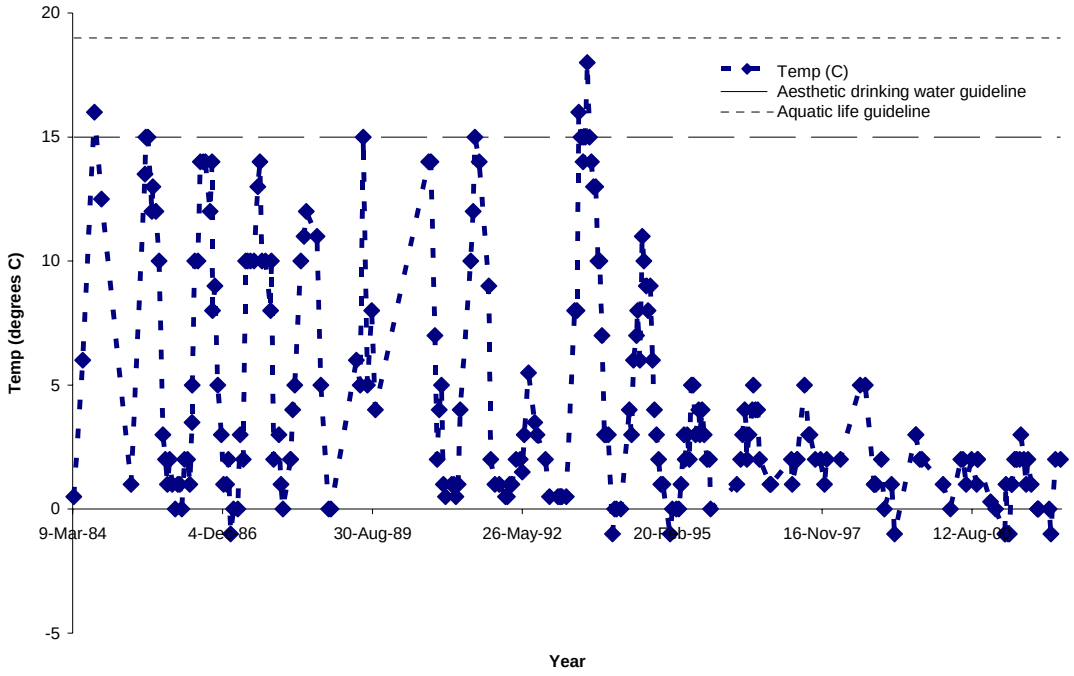

Figure 49. Peace River above Alces River - Thallium, Extractable

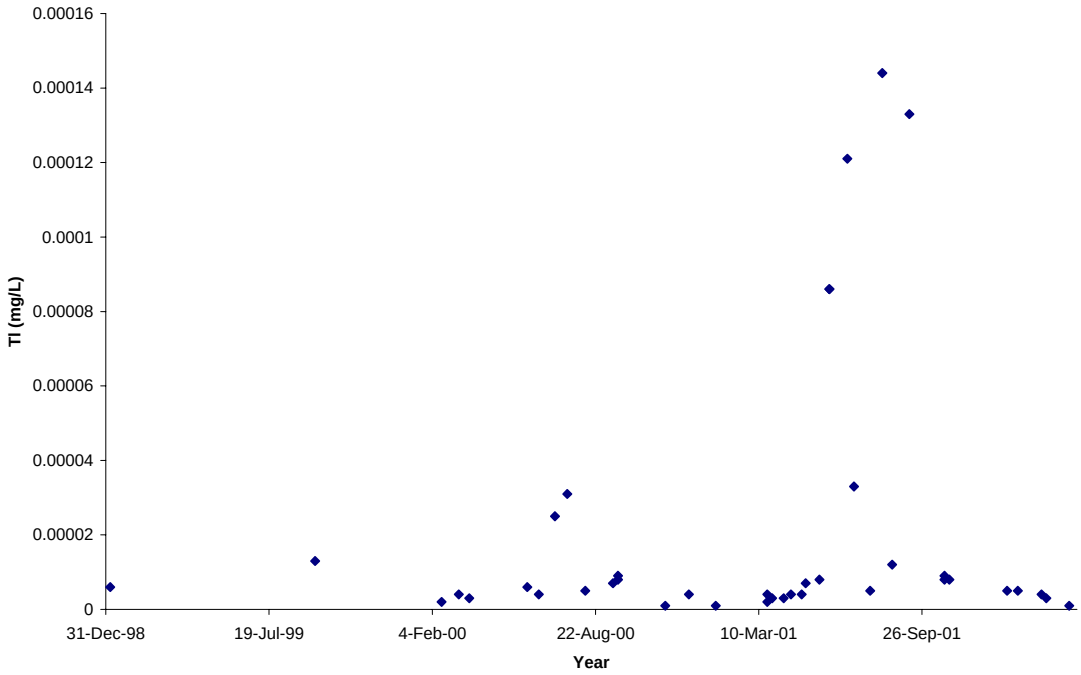

Figure 50. Peace River above Alces River - Turbidity and Average Daily Flow

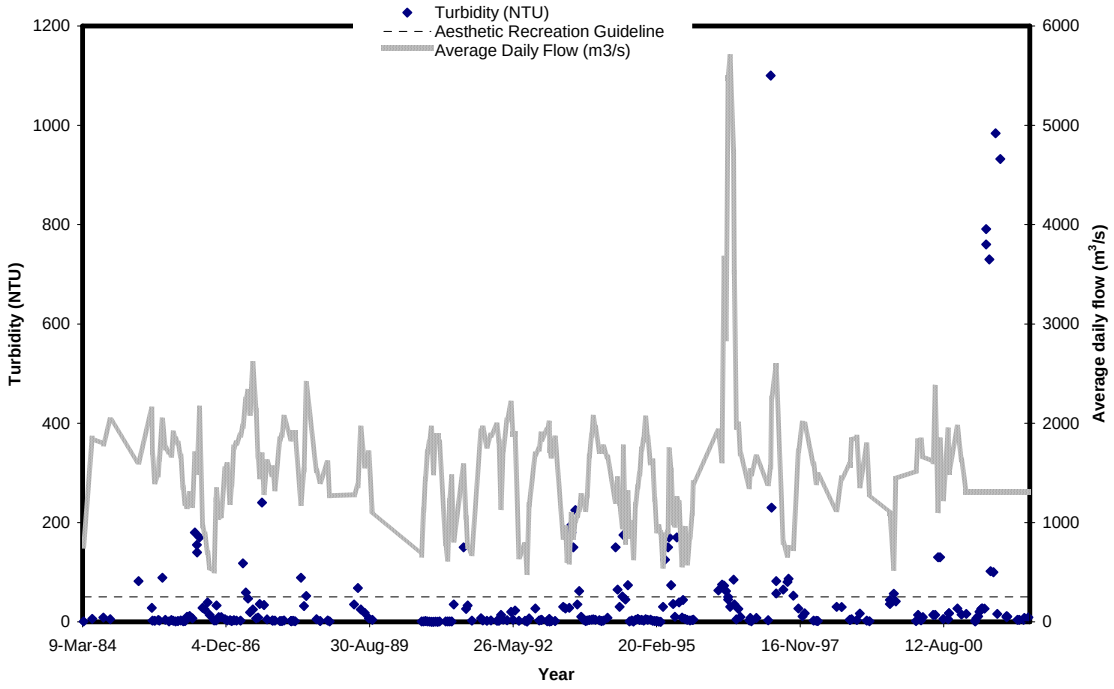

Figure 51. Peace River above Alces River - Uranium, Extractable

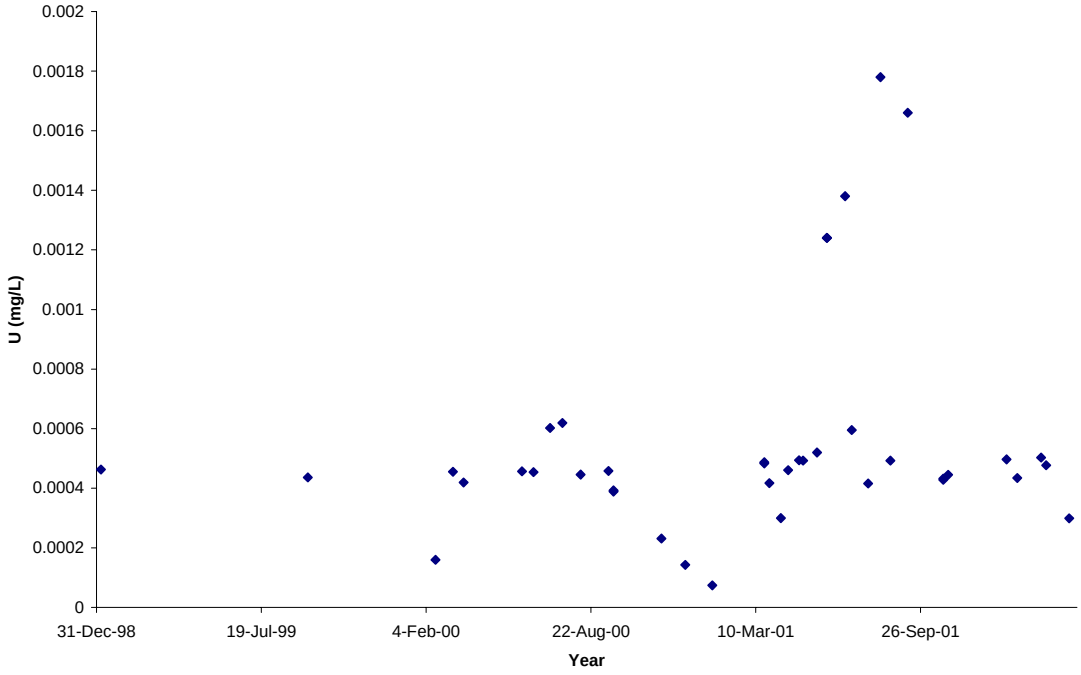

Figure 52. Peace River above Alces - Vanadium, Total and Extractable

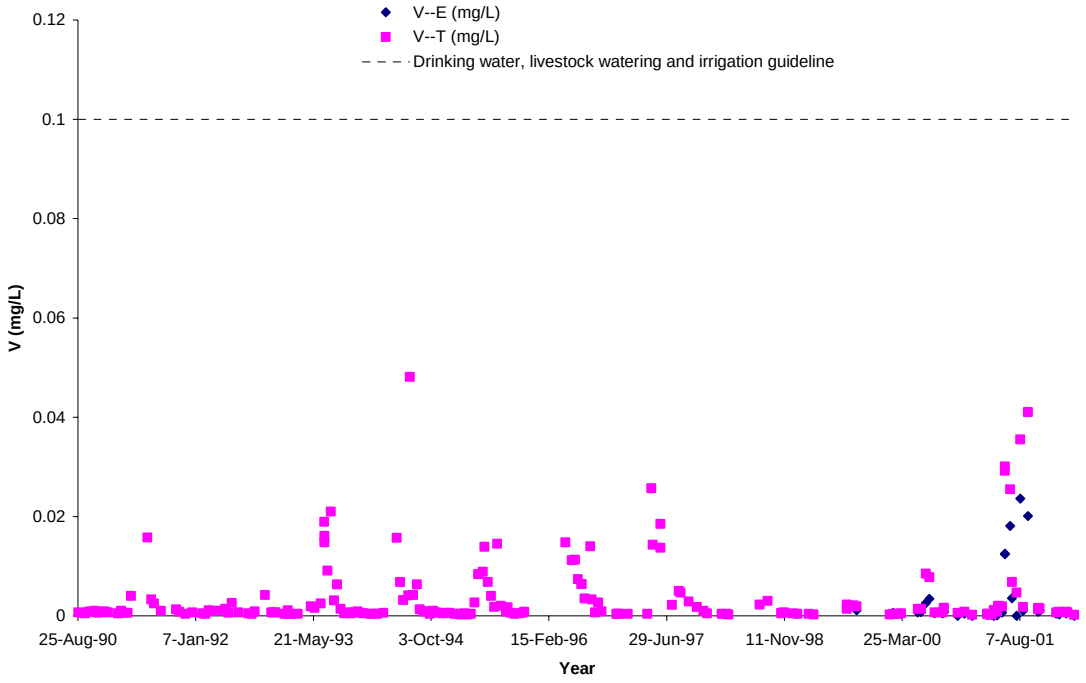

Figure 53. Peace River above Alces River - Zinc, Total and Extractable and Turbidity