

CANADA – BRITISH COLUMBIA

WATER QUALITY MONITORING AGREEMENT

WATER QUALITY ASSESSMENT OF OKANAGAN RIVER AT OLIVER (1979 – 2002)

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**Environment
Canada**

**Environnement
Canada**



**Ministry of
Environment**

EXECUTIVE SUMMARY

The Okanagan River at Oliver is located in the southern interior region of B.C., just upstream from Osoyoos Lake. The river originates at the south end of Okanagan Lake near Penticton and flows south through Skaha, Vaseux, and Osoyoos lakes. Osoyoos Lake straddles the border with the United States. Urbanization, agriculture and logging are the major human impacts in the south Okanagan.

The sampling site is located between Oliver and Osoyoos Lake. This report reviews water quality data collected by Environment Canada and the province for 23 years.

CONCLUSIONS

We concluded that:

- No environmentally significant trends in water quality were detected by visual assessment of the data. Chloride appears to have a trend of increasing concentrations over the period of record.
- Fecal coliforms may have exceeded the guideline for raw drinking water receiving disinfection only. Turbidity removal and disinfection are recommended prior to drinking.
- Aluminum, chromium, iron and zinc all exceeded at least one of their corresponding guidelines on a regular occasion. All of these metals appeared to be closely correlated with turbidity, suggesting that the metals were bound to particulate matter and would not be toxic to biota. As well, filtration necessary to remove excess turbidity prior to use as drinking water would remove these metals as well.
- Concentrations of cadmium were well above guideline limits, but this was due primarily to the high detection limit used in the analyses. A detection limit of no more than one-tenth the guideline limit should be employed as soon as it becomes available in the laboratory.

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- Dissolved organic carbon, true colour, fluoride and sulphate all occasionally exceeded drinking water guidelines.
- The Okanagan River was typically harder than the optimum guidelines for hardness (80 to 100 mg/L) but was still quite acceptable.
- Water temperatures were quite high during the summer months, which makes the Okanagan River good from a recreational point of view, but higher temperatures could harm fisheries and make the water less desirable as a drinking water source.

RECOMMENDATIONS

We recommend monitoring of water quality and flow for the Okanagan River at Oliver be continued because of its proximity to Osoyoos Lake, a trans-boundary water body. A minimum of five fecal coliform samples should be collected within a 30-day period during the summer (when coliforms are typically highest) to make a better statistical assessment of the fecal contamination situation relative to guidelines. In addition, other water quality indicators such as benthic invertebrates, sediment chemistry and fish tissues could also be examined to determine if long-term trends are occurring.

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INTRODUCTION

The Okanagan River at Oliver, B.C., is in the southern central part of the province (Figure 1). It drains an area of 7 590 km² from Enderby upstream from Okanagan Lake to the US border. On the Canadian side, the river flows through several lakes from the south end of Okanagan Lake at Penticton to Osoyoos Lake. The sampling site is located downstream from Oliver and is upstream from Osoyoos Lake. Oliver is located in the warmer and drier part of the Okanagan Valley. Due to this favourable climate, the primary economic activities of the south Okanagan are agriculture (produce and dairy farming), tourism, and logging.

The Okanagan River passes through Skaha and Vaseux lakes on its way to Oliver. The water quality of the river and these lakes are somewhat interdependent. Earlier studies (Zeman *et al.*, 1982) concentrated extensively on nitrogen and phosphorus in the river and the impact of nutrients on the trophic nature of lakes in the Okanagan basin. Earlier studies of Osoyoos Lake, which is just downstream from the Okanagan River at Oliver, found no significant change in its water quality between the mid-1970's and the mid-1990's (Bryan and Jensen, 1994; Bryan, 1995). The *British Columbia Water Quality Status Report* (Ministry of Environment, Lands and Parks, 1996) ranked Osoyoos Lake as "poor" because the spring phosphorus objective (0.015 mg/L) was never met from 1987 to 1993. Recent trend assessment of Skaha and Osoyoos lakes indicates declining phosphorus in response to declining phosphorus loadings from the City of Penticton over the study period (Jensen and Epps, 2002).

This report assesses water quality data collected every two weeks from the Okanagan River at Oliver by Environment Canada and B.C. Environment. Environment Canada operates a flow monitoring station at this location (08NM085). These data are plotted in Figure 2. The station is also known as the Okanagan River at No. 18 Road. There are 22 years of federal data water quality data (under ENVIRODAT station number 08NM0001) and 17 years of provincial data (from EMS site number 0500720). Figures 3 to 49 contain water quality plots of the federal and provincial data. The variables collected by

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the province were non-filterable residue, specific conductivity, fecal coliforms, ammonia and total dissolved phosphorus.

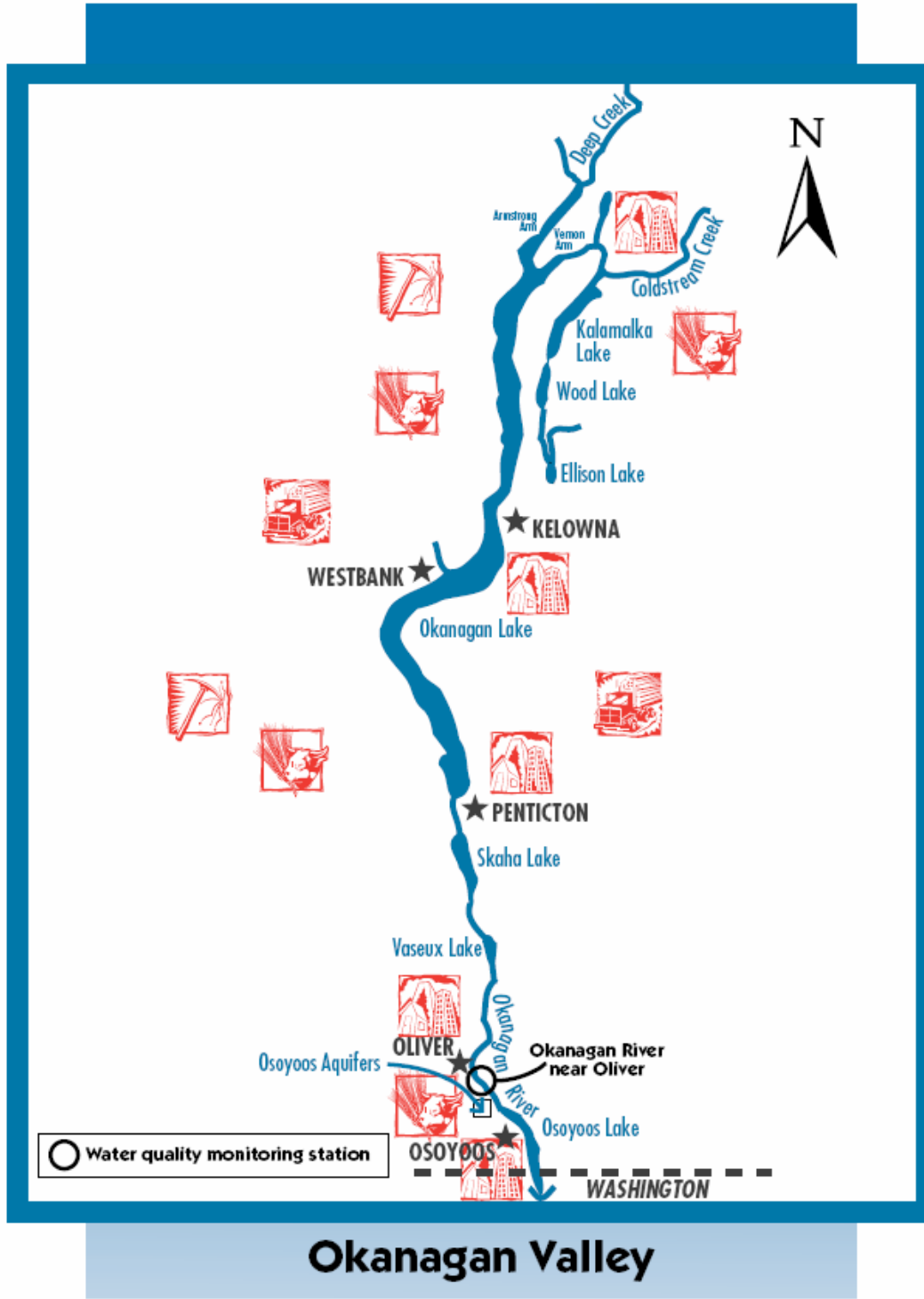


FIGURE 1. OKANAGAN RIVER AT OLIVER

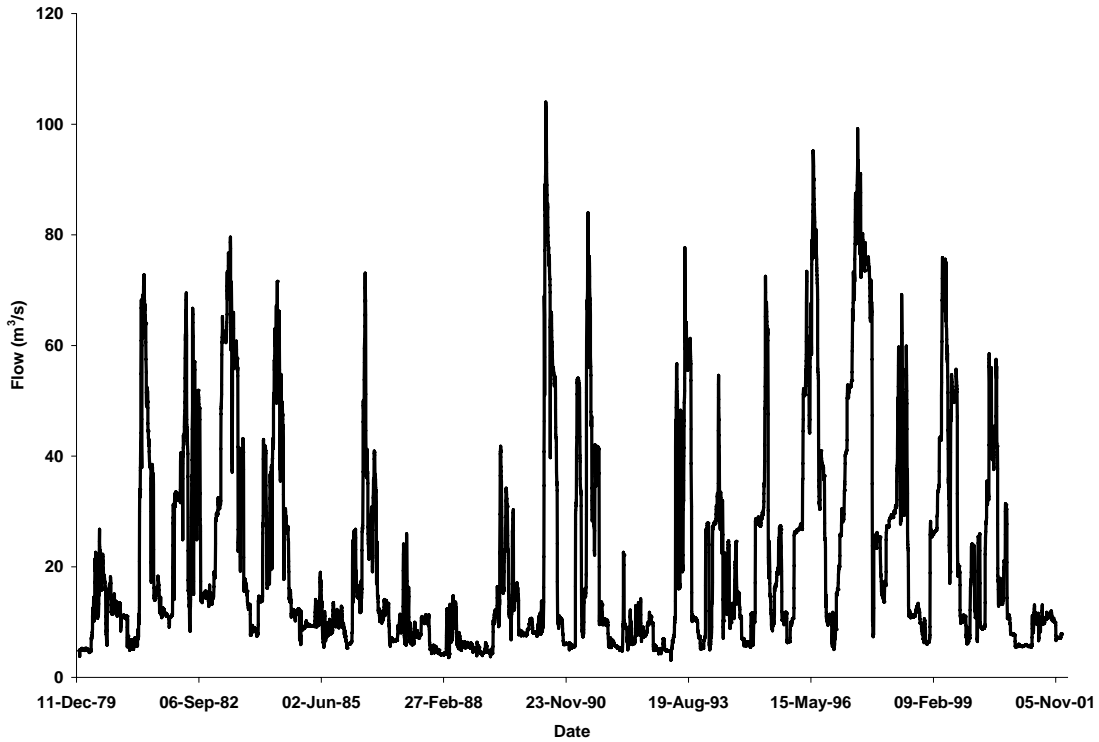


FIGURE 2. WSC FLOW DATA FOR THE OKANAGAN RIVER AT OLIVER (1980-2001)

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 minimum detectable limits (MDLs) and artificial contamination due to the sample collection and laboratory measurement method 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. Mercury monitoring in ambient water was terminated in 1994. Mercury in resident fish tissue should be monitored if there are any mercury concerns upstream in this watershed.

There were known quality assurance problems due to the gradual failure of the re-usable Teflon liners in the bakelite preservative vial caps. Over time, preservatives would leak

and leach out contaminants from the bakelite vial caps and contaminate many of the 1986 to 1991 samples. This contamination problem was known to affect federal water quality data province-wide. The primary variables affected were cadmium, chromium, copper, cyanide, lead, mercury, and zinc during this sampling period. There were known problems due to pH methodology at the Environment Canada Laboratory in Vancouver from the about the beginning of 1986 to the end of 1988.

STATE OF THE WATER QUALITY

The state of the water quality was determined by comparing the values to B.C. Environment's *Approved and Working Criteria for Water Quality* (Nagpal *et al.*, 2001a; 2001b). No site-specific water quality objectives have been developed for the Okanagan River. There are numerous water licenses for domestic use, irrigation and livestock watering for the Okanagan River. Substances not discussed below met guidelines and displayed no environmentally significant trends. They include: ammonia, arsenic, barium, bromide, total, dissolved and inorganic carbon, dissolved oxygen, lead, lithium, magnesium, molybdenum, nickel, nitrogen, phosphorus, potassium, selenium, silicon, silica, silver, sodium, strontium, uranium and vanadium.

Total alkalinity (Figure 3) and **dissolved calcium** (Figure 11) concentrations indicate that the Okanagan River has a low sensitivity to acidic inputs (is well buffered).

Total aluminum concentrations ranged from 0.003 mg/L to 6.35 mg/L. Twenty-three percent (80 of 342 samples) exceeded the aquatic life guideline of 0.1 mg/L, and 12% (42 of 342) exceeded the drinking water guideline of 0.2 mg/L (Figure 4). However, as these guidelines apply to the dissolved form only of aluminum and that form was not measured in this study, an accurate assessment of the guidelines cannot be made. There was a strong correlation between elevated aluminum levels and higher turbidity values (see Figure 4), suggesting that higher aluminum levels are associated with particulate matter and would therefore not be biologically available.

Total cadmium concentrations invariably exceeded the aquatic life guideline of 0.0003 mg/L (Figure 10), but this was due in part to the fact that the detection limits used in the analyses were between 30 and 300 times higher than the guideline limit. Less than 3% of total cadmium samples collected after August 1986 (when detection limits were lowered to 0.0001 mg/L from 0.01 or 0.001 mg/L) exceeded the detection limit, and all values before this time were at or below their respective detection limits. 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 such methods become available.

Dissolved organic carbon (DOC) concentrations exceeded the drinking water guideline of 4 mg/L in 54% of samples (64 of 118) collected between 1997 and 2002 (Figure 14). Elevated levels of DOC can cause flavour problems with water, and when chlorinated can result in elevated levels of trihalomethanes (a suspected carcinogen). There did not appear to be a strong correlation between DOC and turbidity (see Figure 14).

Total chloride concentrations have almost doubled (from 2 mg/L to 4 mg/L) over the period of record (Figure 15), with an R² value of 0.577. This needs to be confirmed statistically to determine whether it is a true significant trend.. It should be noted that there was a change in lab procedures (from an automated colorimetric method to ion chromatography) in mid-1991 for chloride analyses and the detection limit was reduced to 0.02 mg/L. This change in method should not affect the chloride concentrations that are at least ten times higher than this detection limit. Chloride concentrations in Skaha and Okanagan lakes have increased by similar amounts (chloride in Skaha Lake has increased from approximately 1.75 mg/L in the late 1970;s to about 3.75 mg/L in recent years).

Total chromium concentrations measured prior to 1991 may have been elevated due to suspected preservative vial contamination (Figure 16). Since that time, 49 values (17% of 293 values collected) exceeded the aquatic life guideline of 0.001 mg/L, and six values (2%) exceeded the irrigation guideline of 0.005 mg/L. The maximum recorded

concentration after 1991 was 0.0679 mg/L. Elevated levels of total chromium were associated with elevated turbidity levels (see Figure 16), suggesting that the chromium was associated with particulate matter and therefore not available to biota.

Total cobalt levels were generally low (Figure 17) with only 4 of 311 values (1%) exceeding the aquatic life guideline of 0.0009 mg/L, and no values exceeding the irrigation guideline of 0.05 mg/L (Figure 17).

Fecal coliform concentrations ranged from below detectable limits (<1 CFU/100 mL) to a maximum reported value of < 20,000 CFU/100 mL. The guideline for drinking water undergoing chlorination only is that the 90th percentile should be < 10 CFU/100 mL. Although data were not collected at an adequate frequency to determine 90th percentile values, the guideline was exceeded by 25% of individual samples, suggesting that coliforms frequently degrade water quality at this site and that drinking water will require partial treatment (i.e. filtration) as well as disinfection prior to consumption. The source of these coliforms is unclear, as the City of Oliver ceased the discharge of secondary sewage in 1984.

The drinking water quality objective for **colour** is expressed in terms of true colour. This method of measurement has been used only since 1997 for the Okanagan River. Of the 129 samples collected between 1997 and 2002 and analyzed for true colour, nine (or 7%) exceeded the drinking water guideline, invariably during the spring freshet (Figure 19).

Total copper levels were elevated between 1986 and 1991 due to suspected preservative vial contamination (Figure 21). Since that time, only one individual value exceeded the 30-day average guideline for the protection of aquatic life, and no values exceeded the maximum aquatic life guideline (see inset, Figure 21). As a minimum of five samples collected within a 30-day period must be averaged to assess the average copper guideline, no exceedences of this guideline occurred.

The guideline for the protection of aquatic life from **dissolved fluoride** is hardness-dependent. As hardness concentrations in the Okanagan River are consistently higher than 50 mg/L (see Figure 24), the applicable aquatic-life guideline is 0.3 mg/L. Ten samples (3% of 298 samples) collected between 1982 and 1997 exceeded this guideline (Figure 23).

Total hardness concentrations ranged from 51 mg/L to 143 mg/L, with the majority of values lying between 100 and 150 mg/L (Figure 24). Only 7% of values were within the optimum range for drinking water (between 80 and 100 mg/L).

Total iron concentrations were measured 475 times between 1981 and 2002, with 34 values (7% of samples) exceeding the aquatic life and aesthetic drinking water guideline of 0.3 mg/L (Figure 25). The exceedences occurred primarily during spring freshet, and the strong correlation between total iron and turbidity indicates that higher levels of iron are associated with particulate matter. This would mean that they were not biologically available and would be removed by treatment necessary for elevated turbidity levels prior to consumption in drinking water.

Total manganese concentrations exceeded both the drinking water and irrigation guidelines on a few occasions prior to 1991 (Figure 29). However, since that time no guideline has been exceeded.

pH values in the Okanagan River were generally slightly basic, with values typically between 7.8 and 8.3 pH units (Figure 35). The upper drinking water guideline of 8.5 pH units was exceeded on nine occasions between 1979 and 2002 (1% of values). Two very low values were reported (1.63 pH units, on August 29, 1995 and 1.57 pH units on November 20, 1996) on the same dates that extremely high specific conductivity values were reported. These extreme values are very unlikely to represent actual conditions and are probably the result of either a laboratory or reporting error. Values reported between 1986 and 1988 were artificially low due to a problem with control in the laboratory.

Non-filterable residue (total suspended solids) concentrations were seasonally correlated, with maximum values occurring annually during spring freshet. Values ranged from below detectable limits (< 1 mg/L) to a maximum of 357 mg/L (Figure 38). Six percent of values (16 of 269 samples) exceeded the general fisheries guideline of 25 mg/L.

Dissolved sulphate concentrations were generally below the aquatic life alert guideline of 50 mg/L with the exception of one value (128 mg/L on October 19, 1993) (Figure 44). It is not likely that sulphate is a concern at this site.

Water temperatures in the Okanagan River regularly exceeded both the aesthetic drinking water guideline of 15°C and the general fisheries guideline of 19°C during summer months (July and August) (Figure 45). Summer water temperatures were always warm enough for recreational use ($> 15^{\circ}\text{C}$).

Turbidity levels in the Okanagan River were closely associated with water flow (see Figure 46), with peak values generally occurring during spring freshet. Forty-eight percent of values (281 of 590 values collected between 1979 and 2002) exceeded the drinking water guideline of 1 NTU, while 9% also exceeded the aesthetic drinking water guideline of 5 NTU. Only three values exceeded the recreation guideline of 50 NTU. Turbidity removal is required before water can be used for drinking.

Total zinc concentrations were artificially elevated between 1986 and 1991 due to preservative vial contamination. Since that time, only three individual values exceeded the average aquatic life guideline (approximately 0.031 mg/L based on an average hardness of 117 mg/L) and two of these also exceeded the maximum guideline (0.057 mg/L) (Figure 49).

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Figure 3. Okanagan River at Oliver - Alkalinity, Total

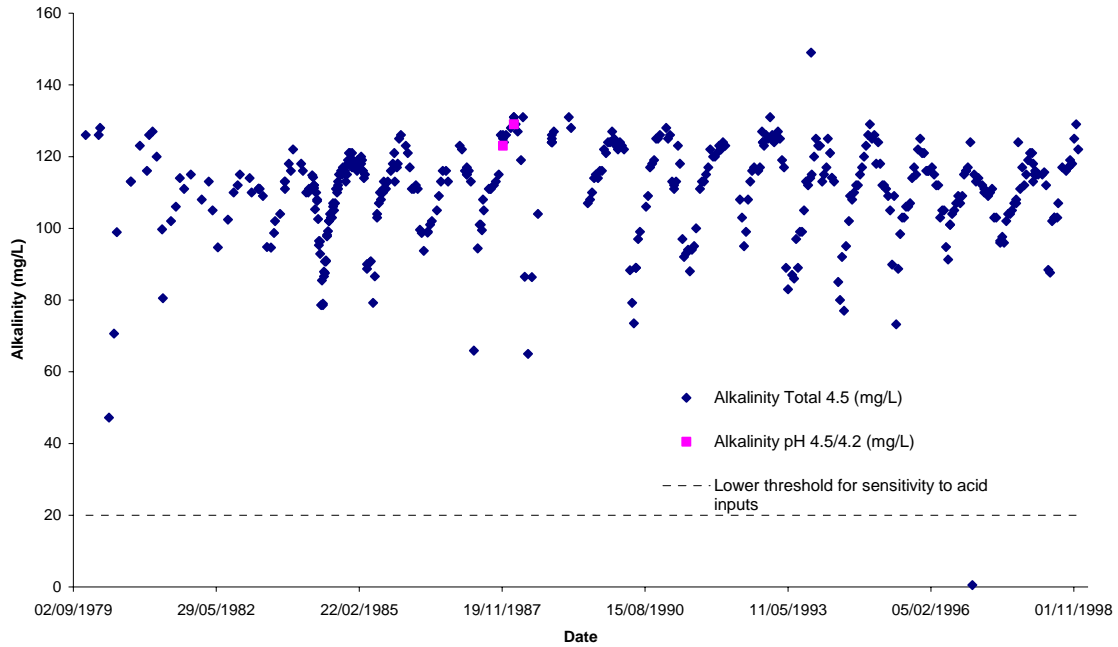
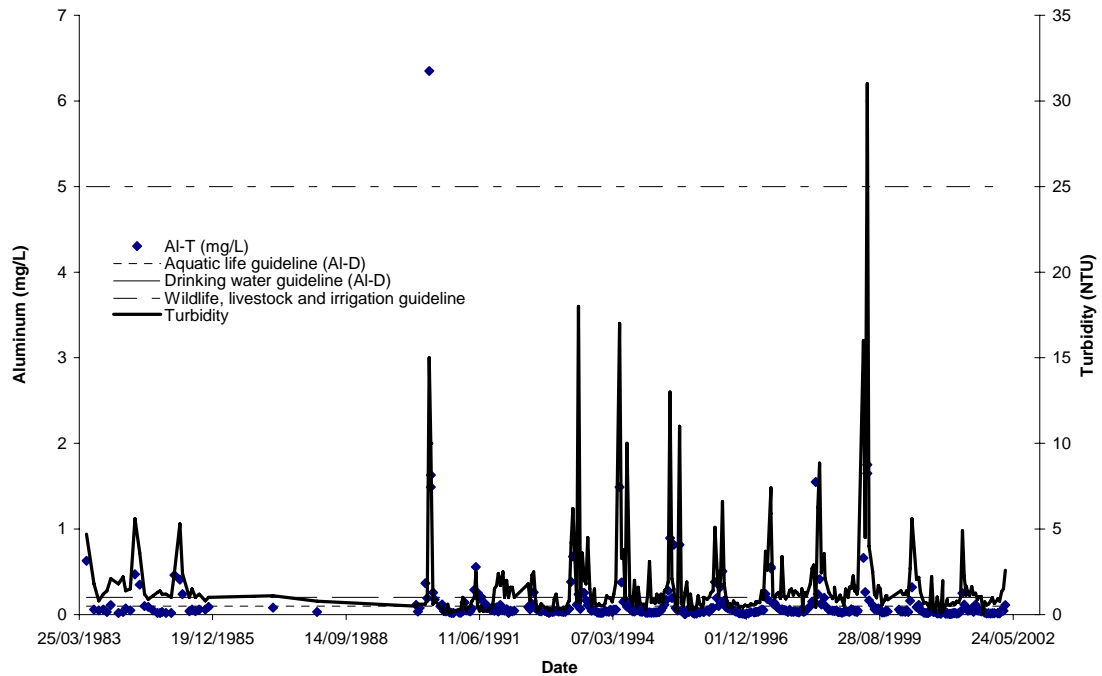


Figure 4. Okanagan River at Oliver - Aluminum, Total



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Figure 5. Okanagan River at Oliver - Ammonia, Dissolved

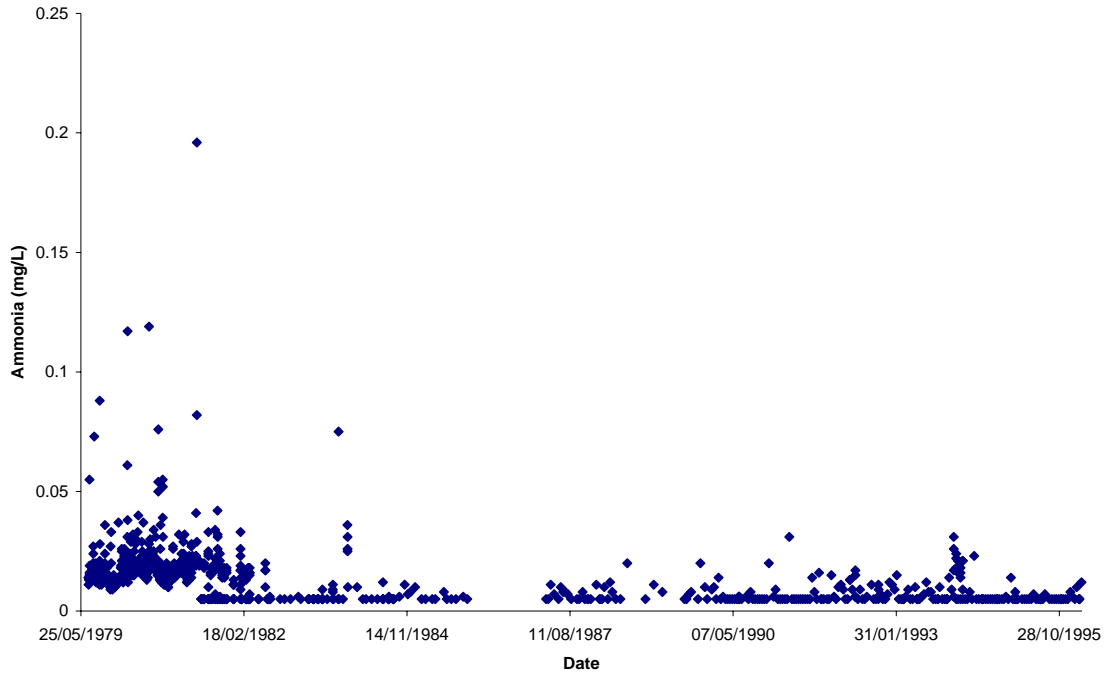
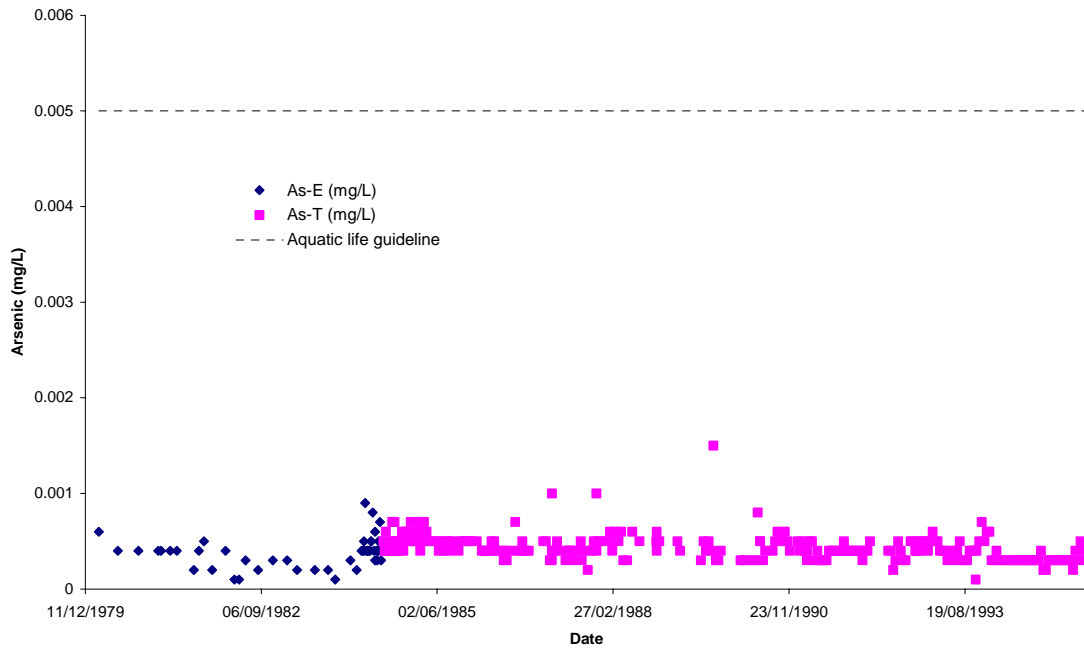


Figure 6. Okanagan River at Oliver - Arsenic, Total and Extractable



Water Quality Assessment of the Okanagan River at Oliver, 1979-2002

Figure 7. Okanagan River at Oliver - Barium, Total

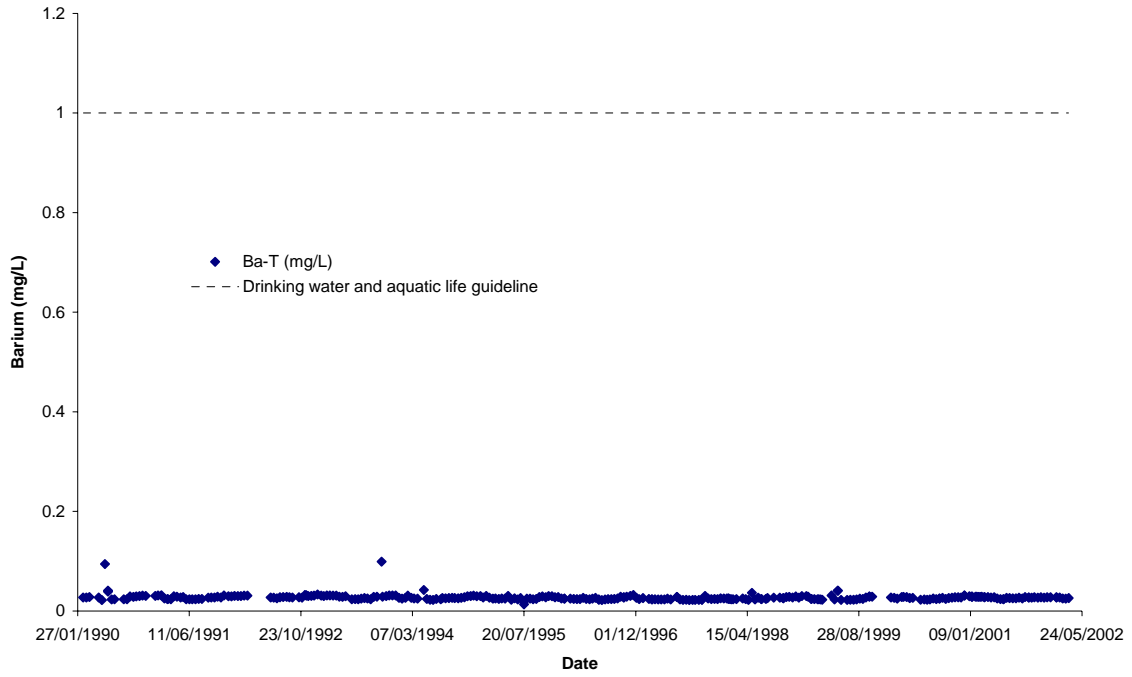
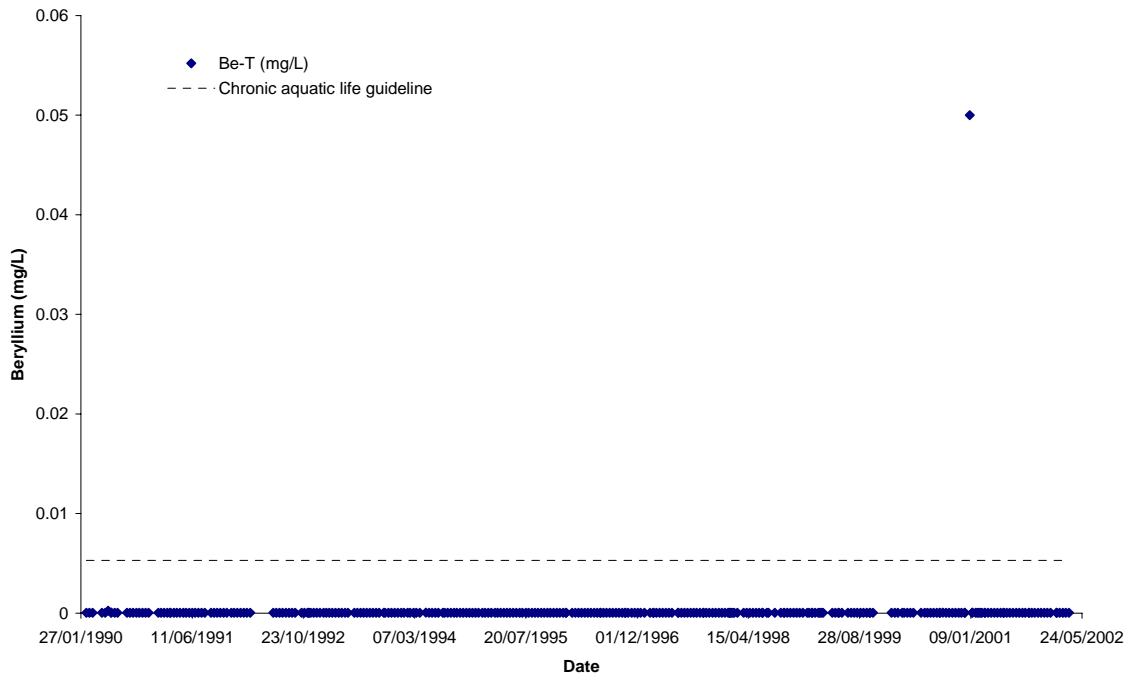


Figure 8. Okanagan River at Oliver - Beryllium, Total



Water Quality Assessment of the Okanagan River at Oliver, 1979-2002

Figure 9. Okanagan River at Oliver - Bromide, Dissolved

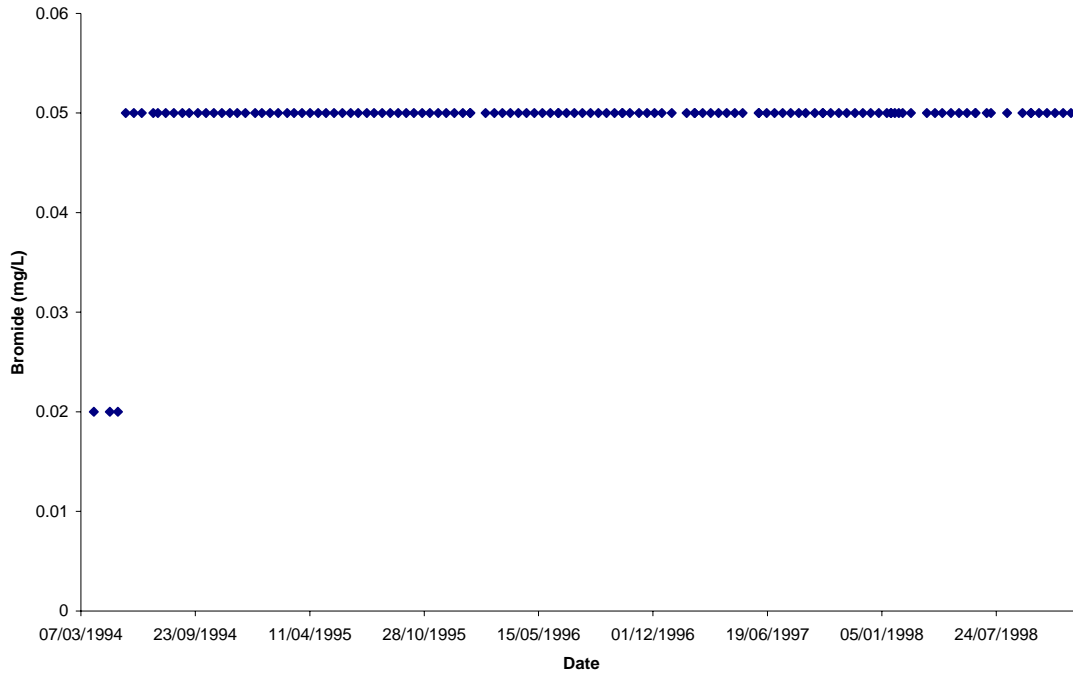
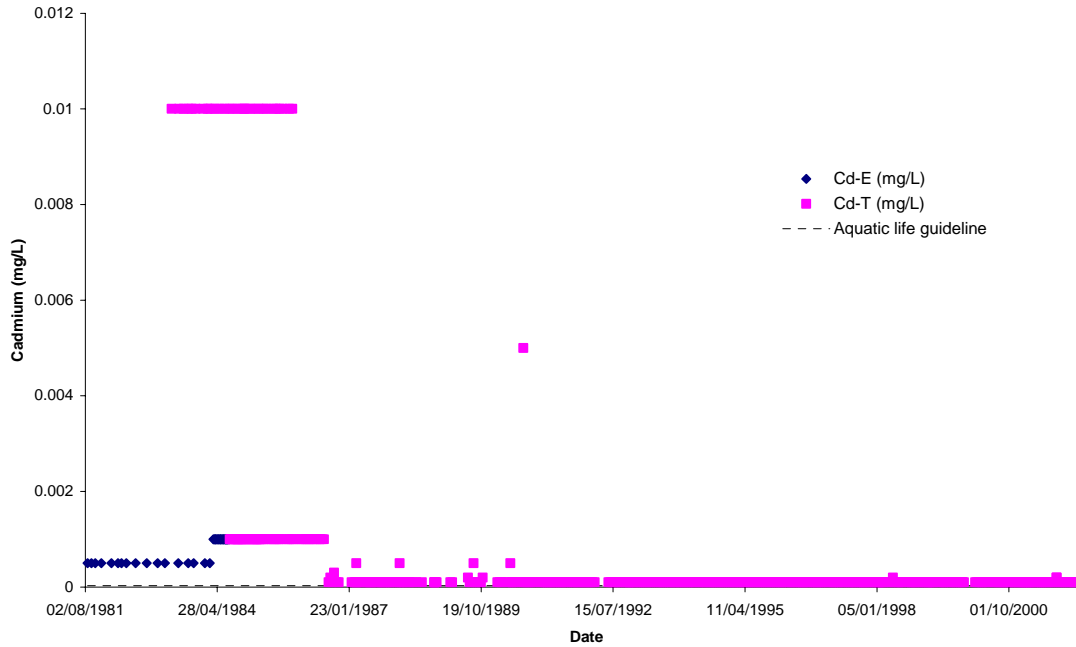


Figure 10. Okanagan River at Oliver - Cadmium, Total and Extractable



Water Quality Assessment of the Okanagan River at Oliver, 1979-2002

Figure 11. Okanagan River at Oliver - Calcium, Total, Dissolved and Extractable

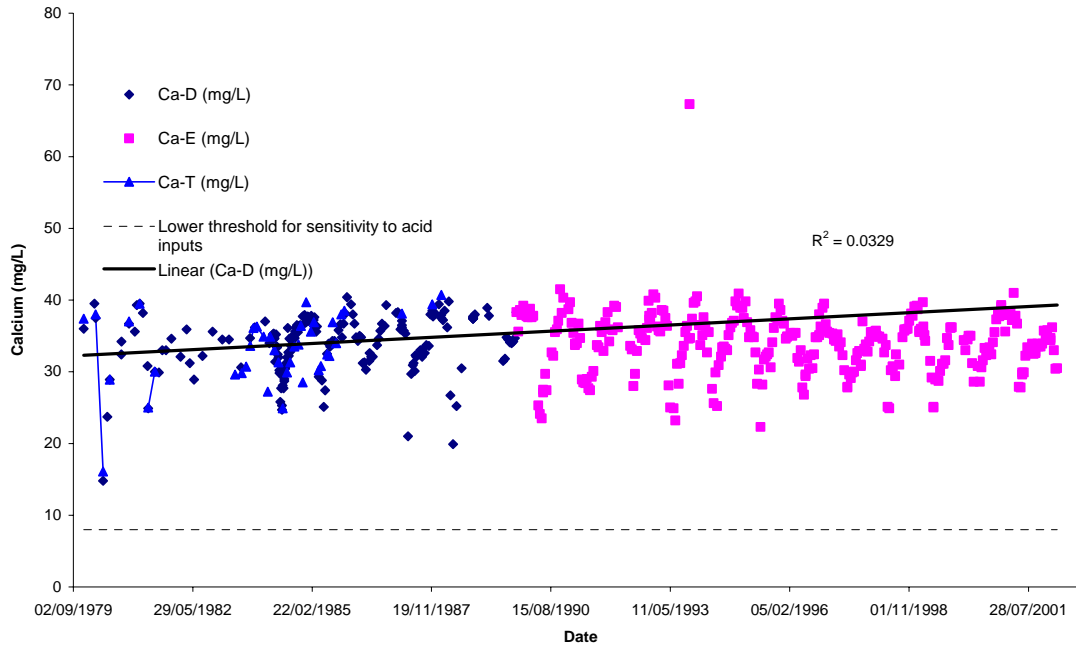
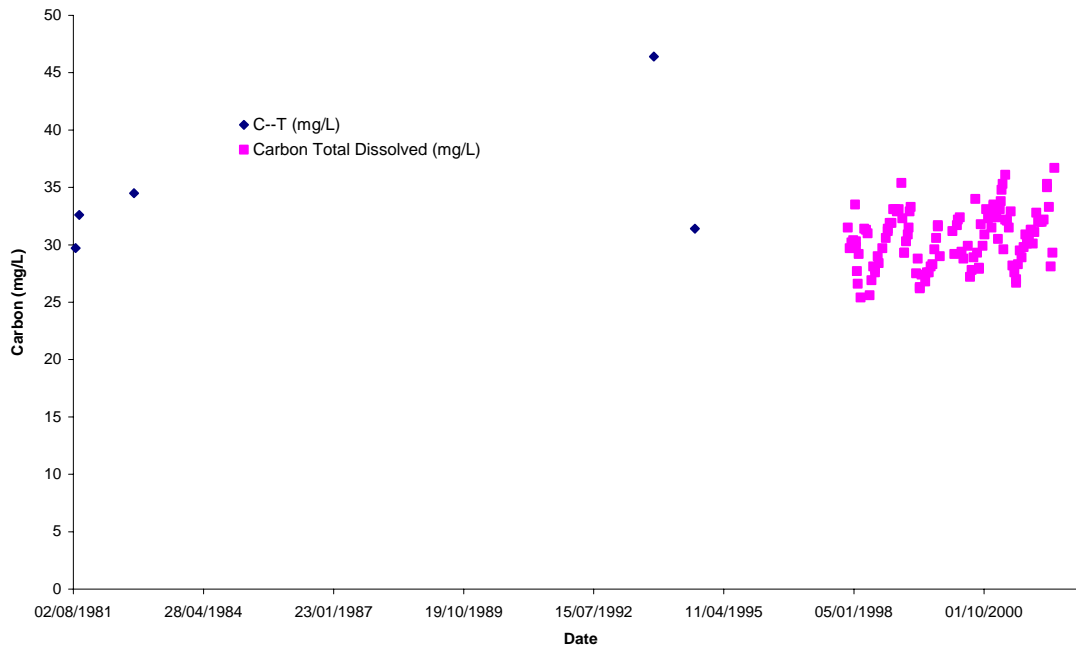


Figure 12. Okanagan River at Oliver - Carbon, Total and Dissolved



Water Quality Assessment of the Okanagan River at Oliver, 1979-2002

Figure 13. Okanagan River at Oliver - Carbon, Total Inorganic and Dissolved Inorganic

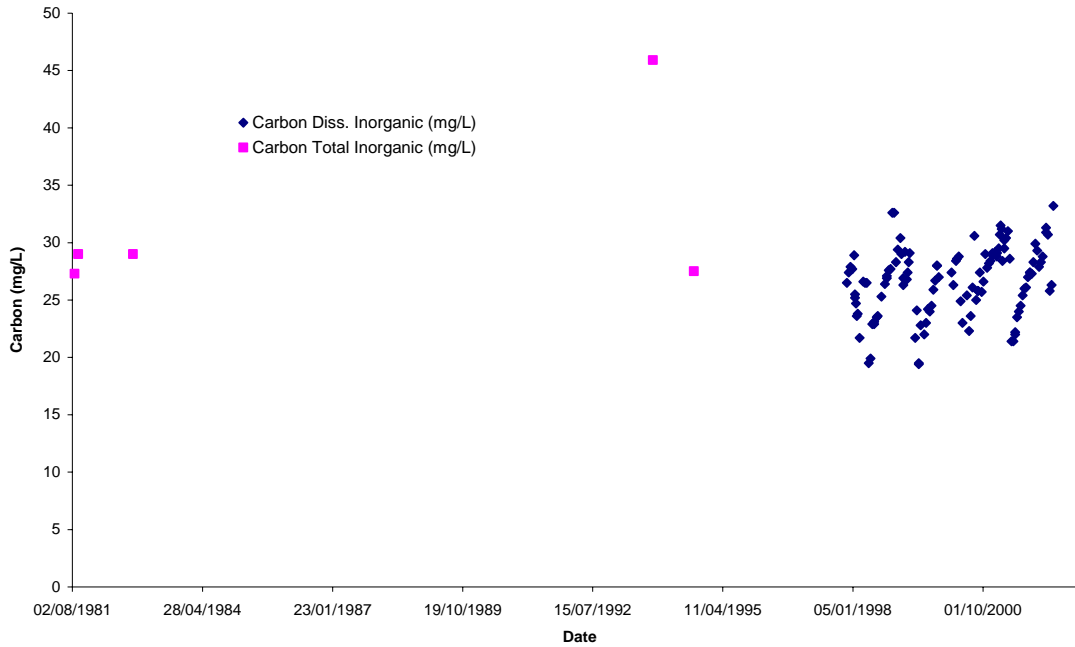
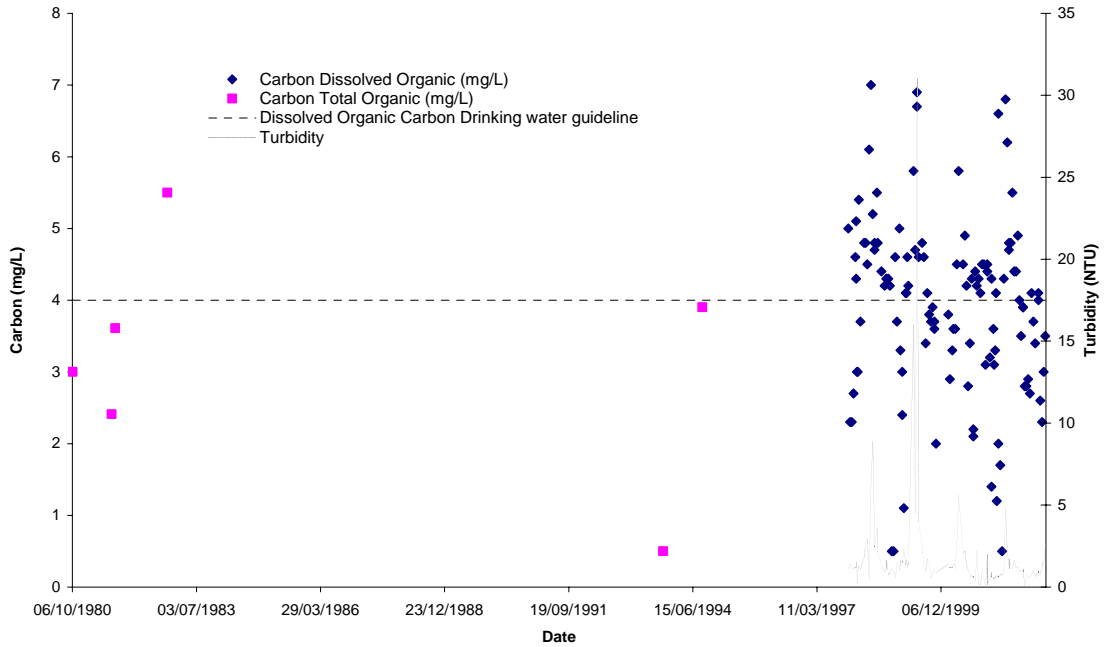


Figure 14. Okanagan River at Oliver - Carbon, Total Organic and Dissolved Organic



Water Quality Assessment of the Okanagan River at Oliver, 1979-2002

Figure 15. Okanagan River at Oliver - Chloride, Dissolved

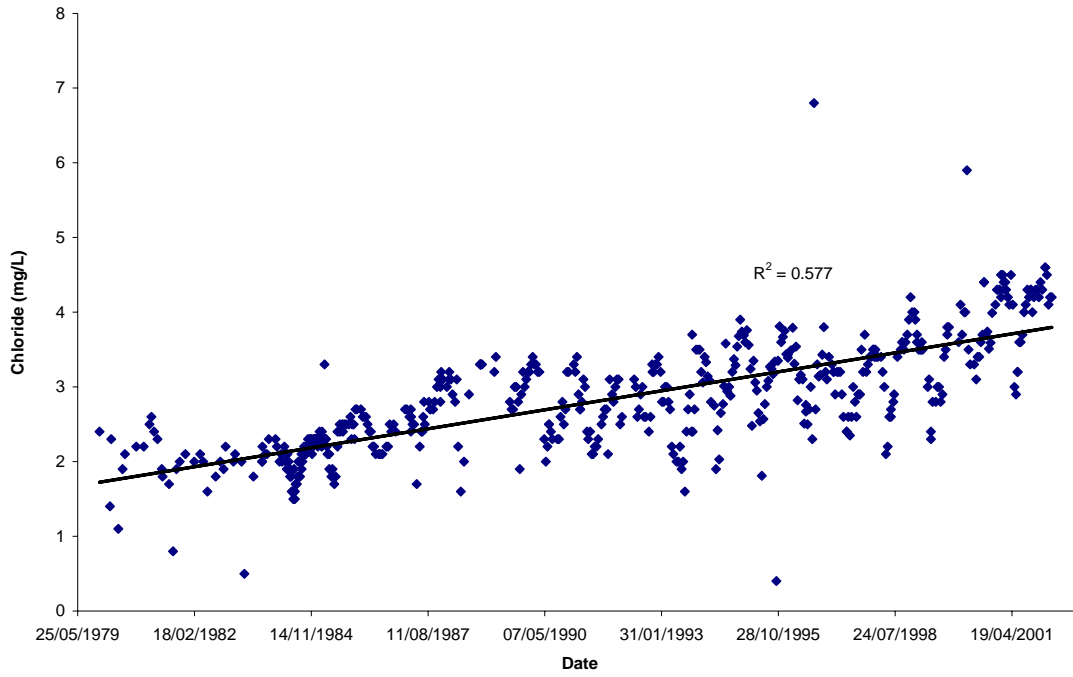
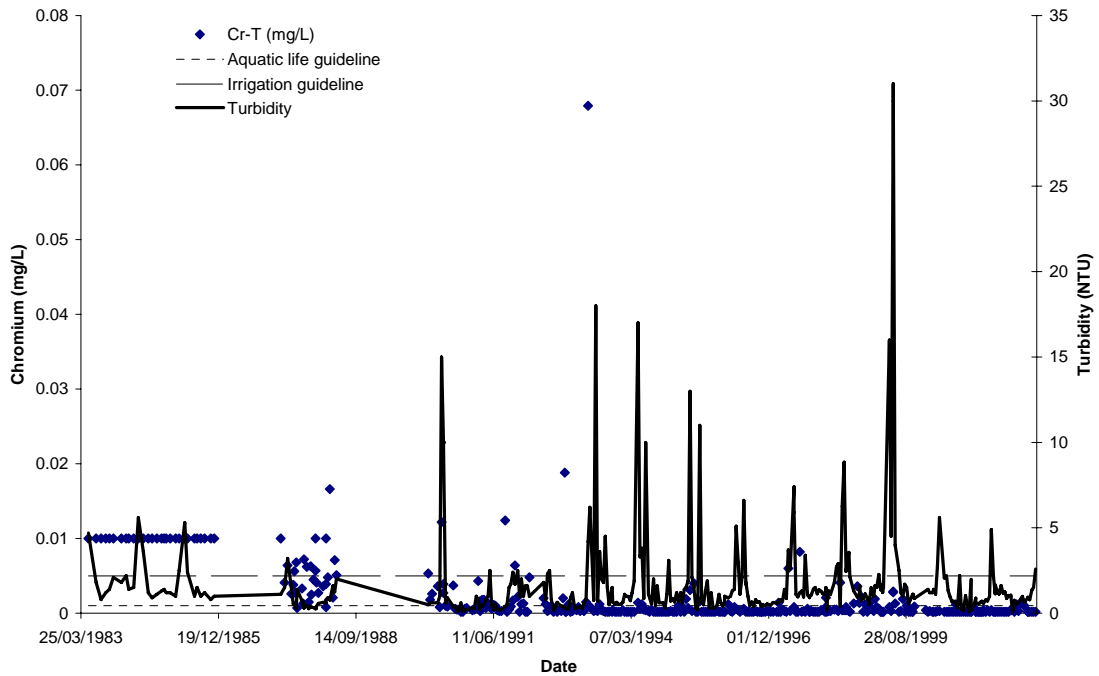


Figure 16. Okanagan River at Oliver - Chromium, Total, and Turbidity



Water Quality Assessment of the Okanagan River at Oliver, 1979-2002

Figure 17. Okanagan River at Oliver - Cobalt, Total

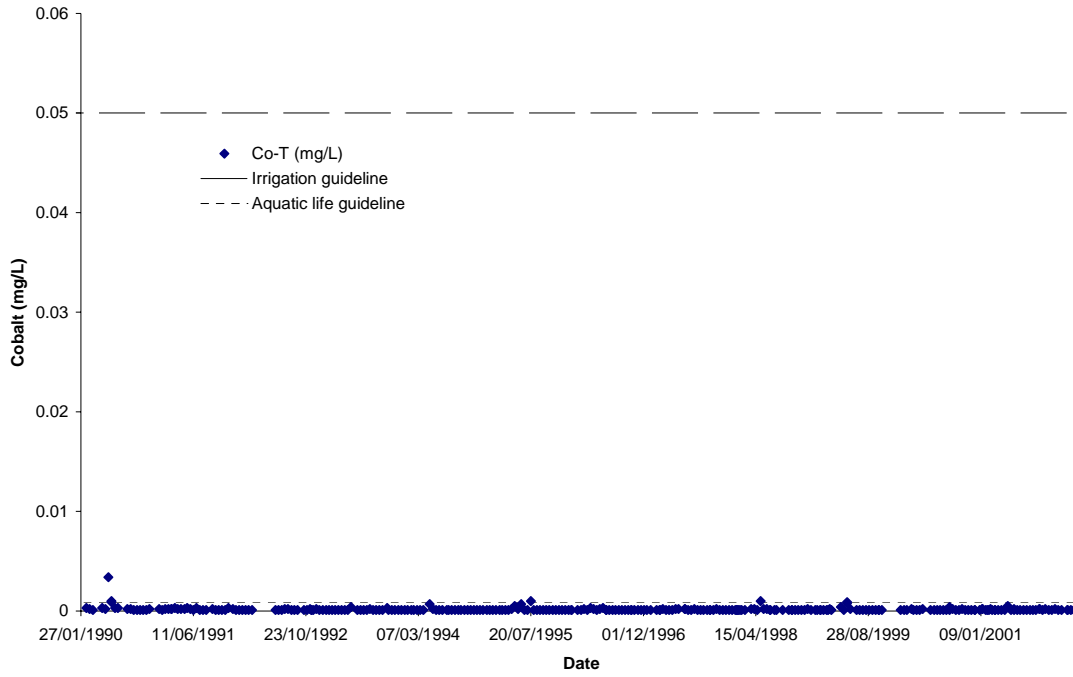
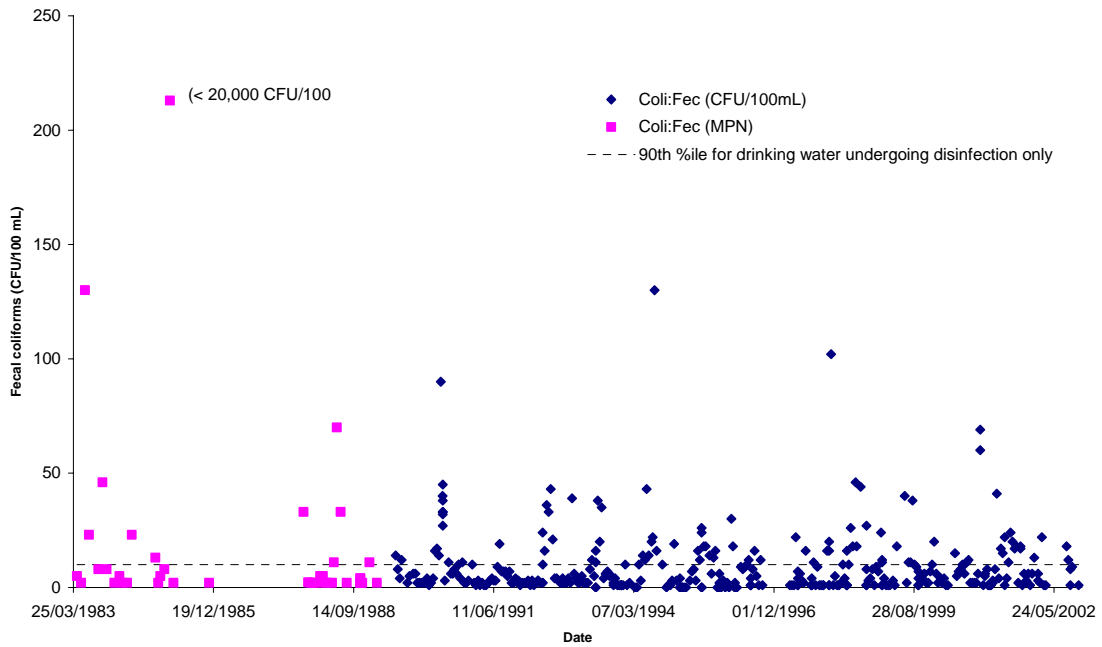


Figure 18. Okanagan River at Oliver - Coliforms, Fecal



Water Quality Assessment of the Okanagan River at Oliver, 1979-2002

Figure 19. Okanagan River at Oliver - Colour, True, Apparent and TAC

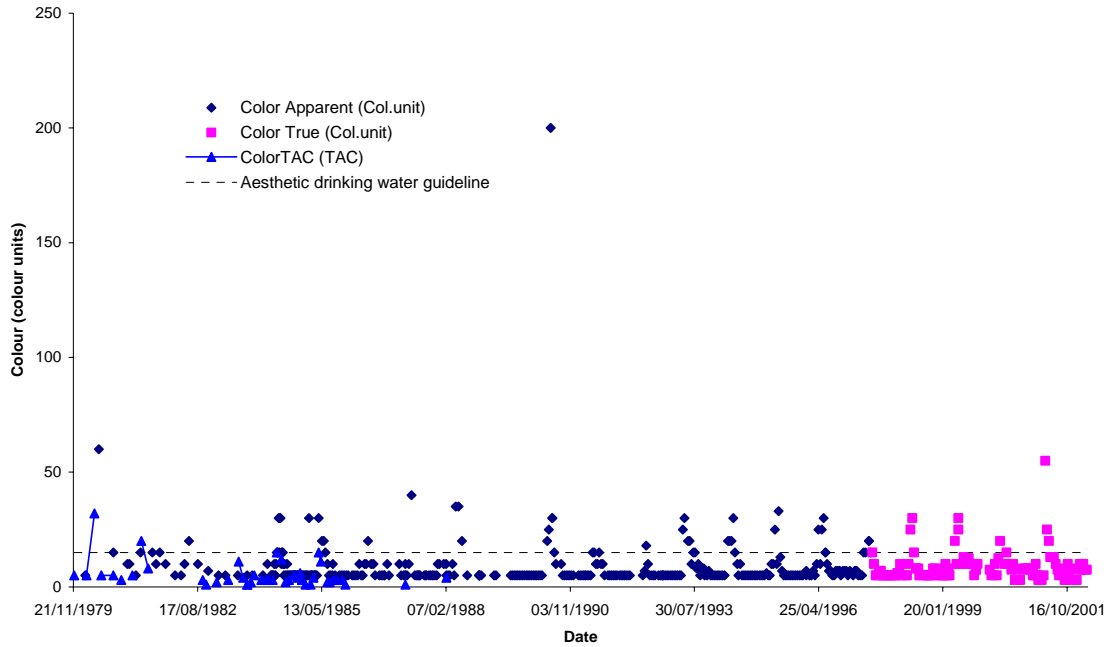
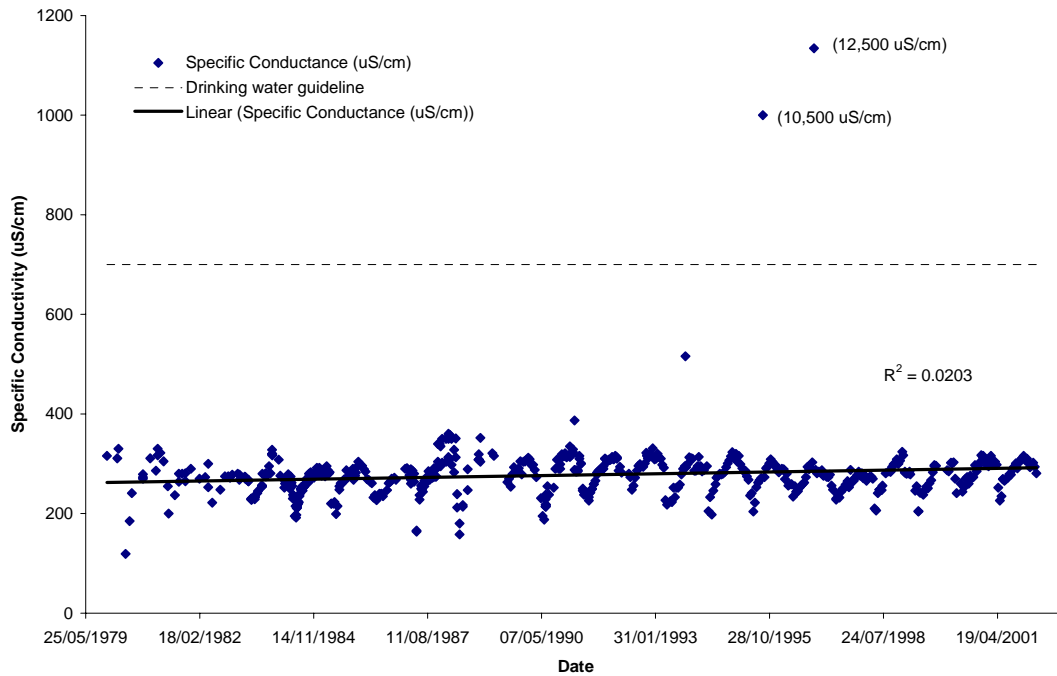


Figure 20. Okanagan River at Oliver - Conductivity, Specific



Water Quality Assessment of the Okanagan River at Oliver, 1979-2002

Figure 21. Okanagan River at Oliver - Copper, Total and Extractable (inset shows total copper data between 1991 and 2002 only)

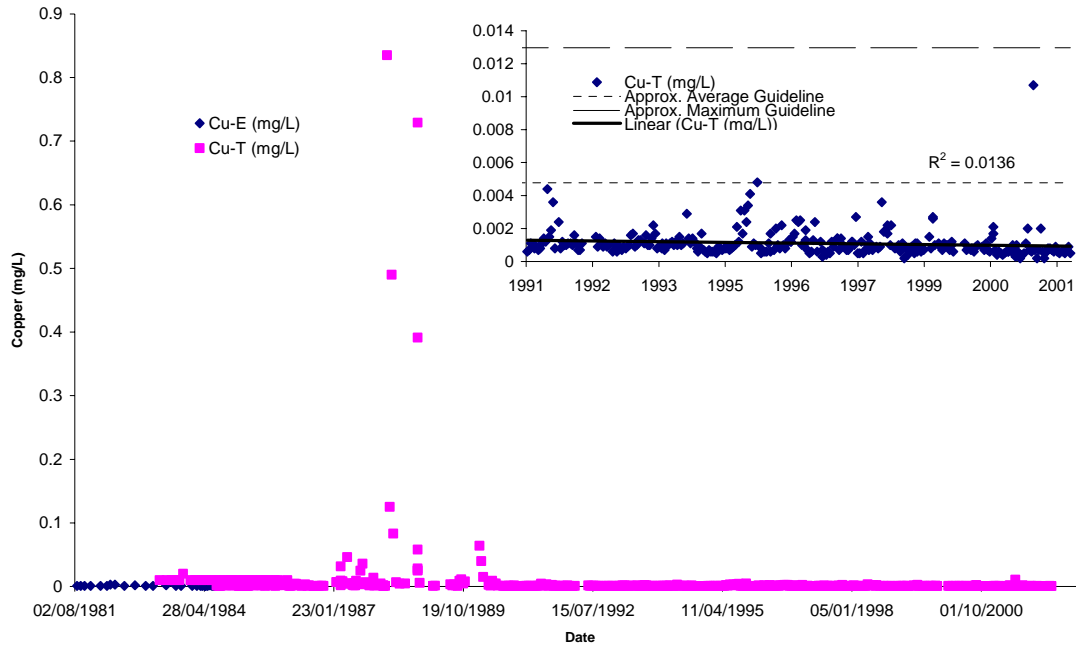


Figure 22. Okanagan River at Oliver - Oxygen, Dissolved

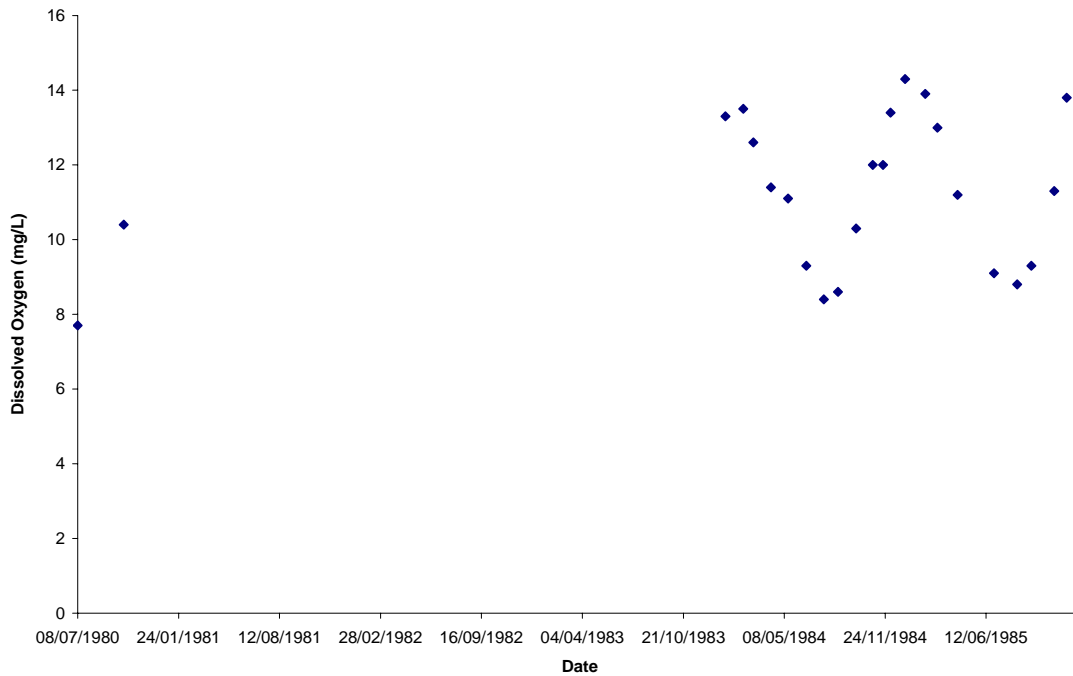


Figure 23. Okanagan River at Oliver - Fluoride, Dissolved and Total

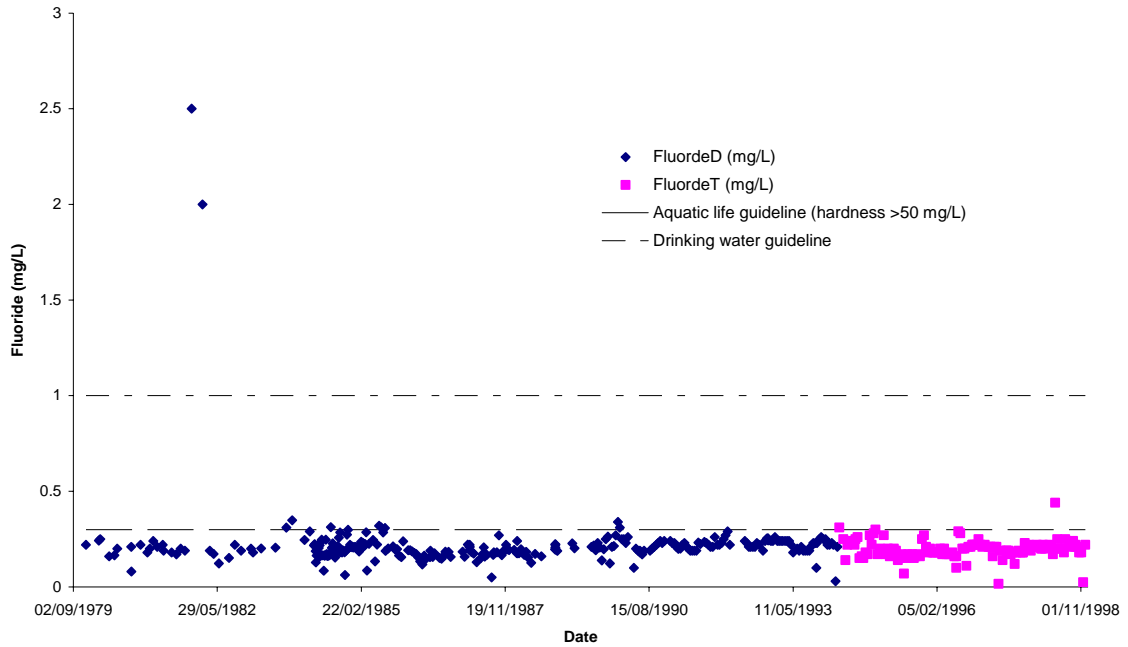
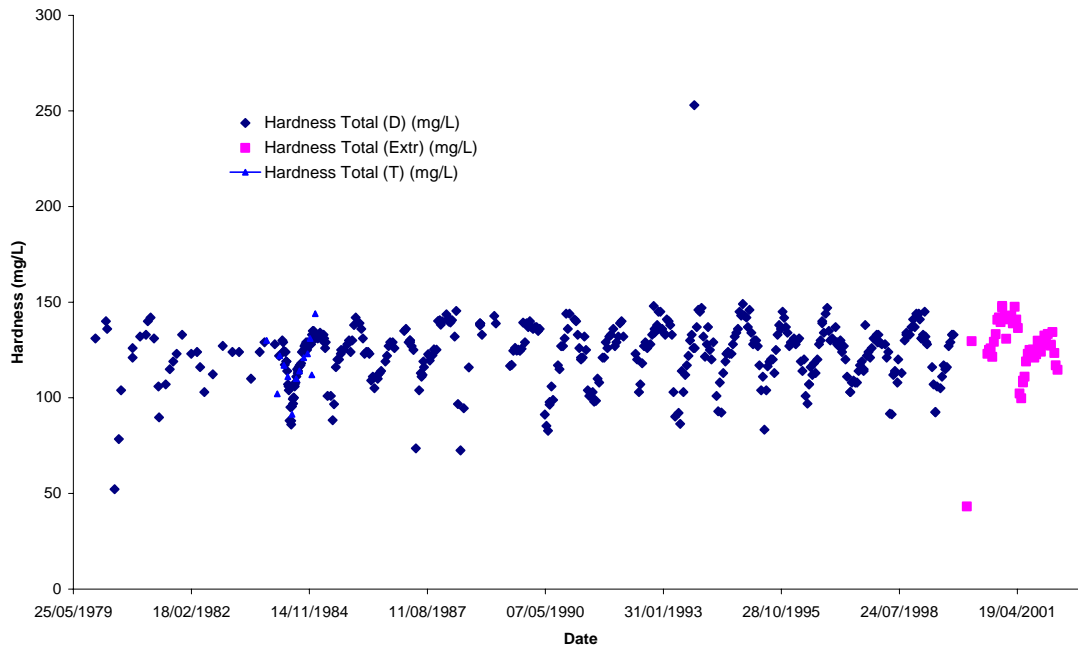


Figure 24. Okanagan River at Oliver - Hardness, Total, Dissolved and Extractable



Water Quality Assessment of the Okanagan River at Oliver, 1979-2002

Figure 25. Okanagan River at Oliver - Iron, Total and Extractable and Turbidity

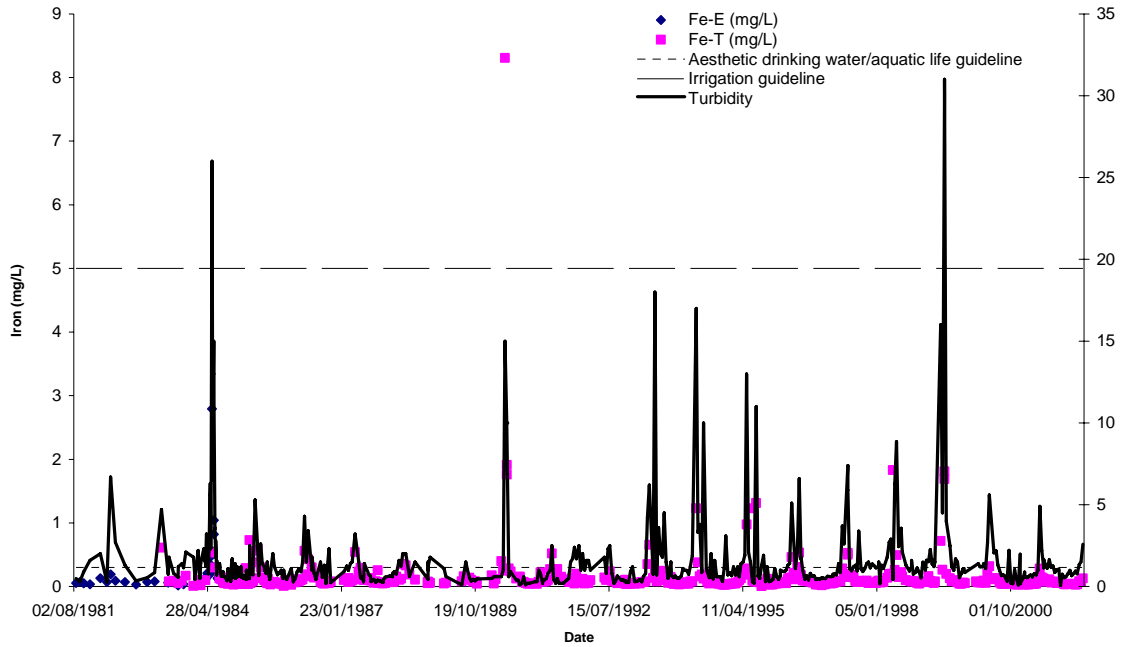
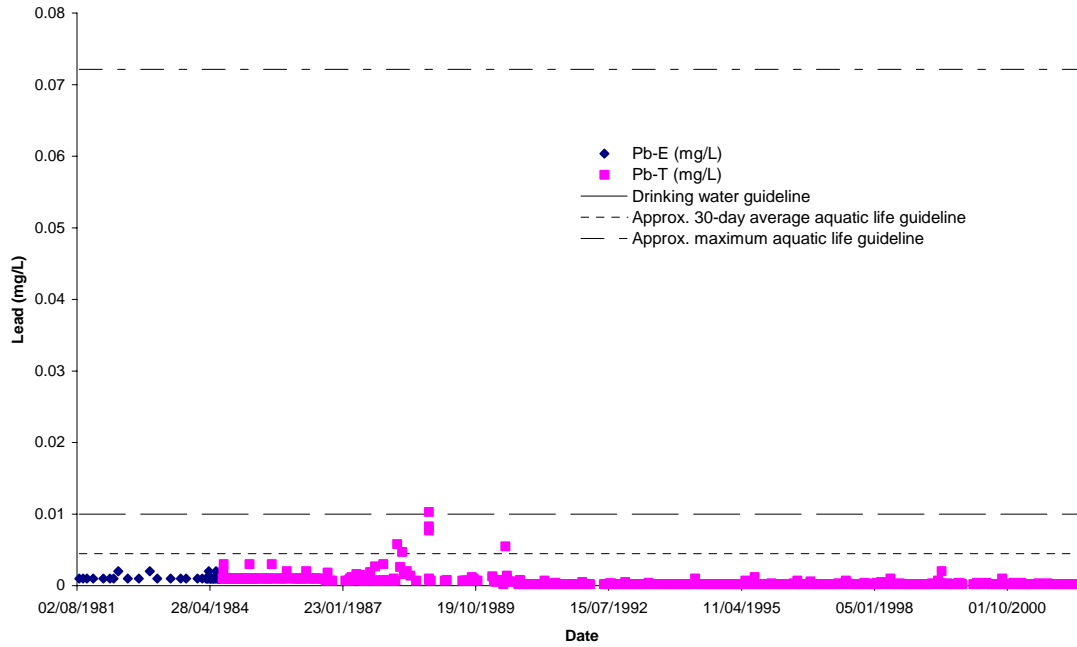


Figure 26. Okanagan River at Oliver - Lead, Total and Extractable



Water Quality Assessment of the Okanagan River at Oliver, 1979-2002

Figure 27. Okanagan River at Oliver - Lithium, Total

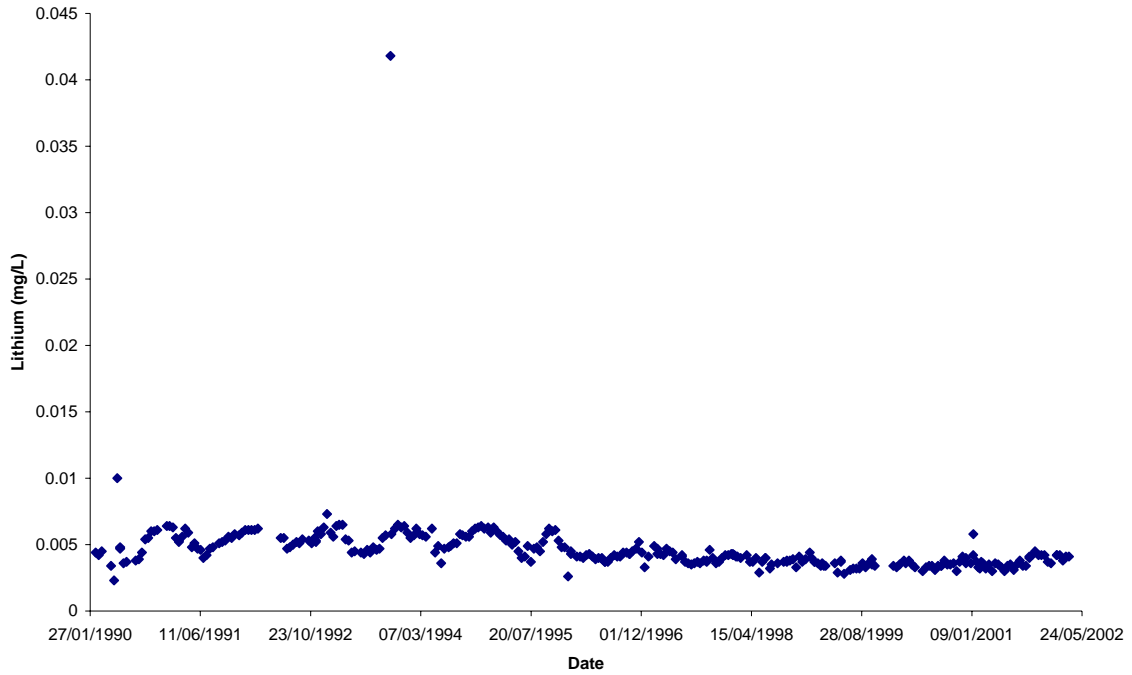
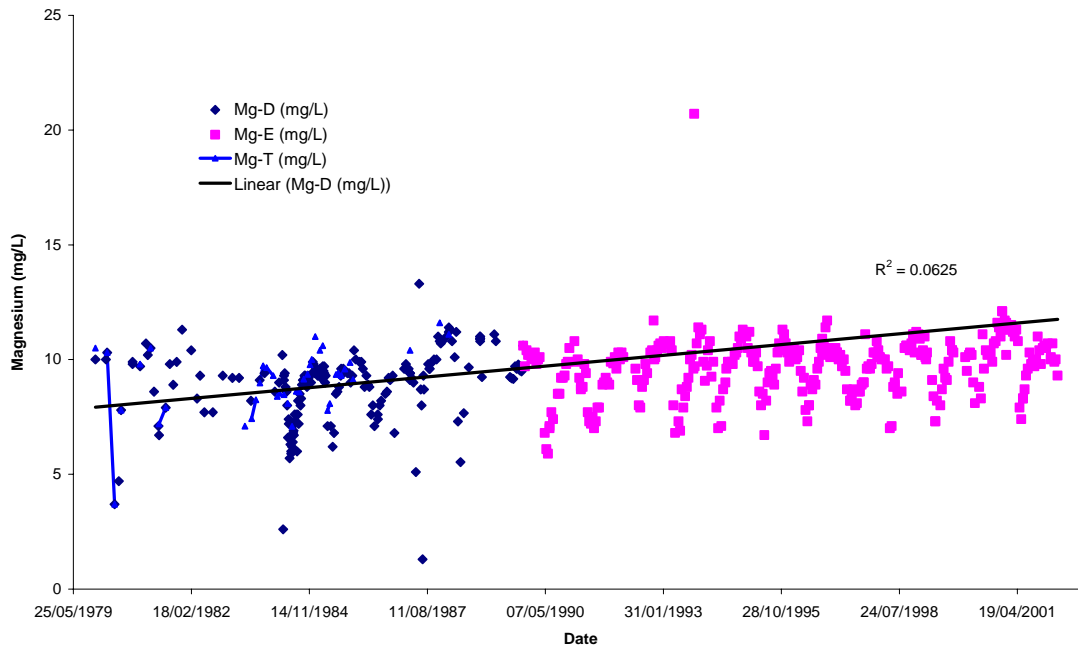


Figure 28. Okanagan River at Oliver - Magnesium, Total, Dissolved and Extractable



Water Quality Assessment of the Okanagan River at Oliver, 1979-2002

Figure 29. Okanagan River at Oliver - Manganese, Total and Extractable

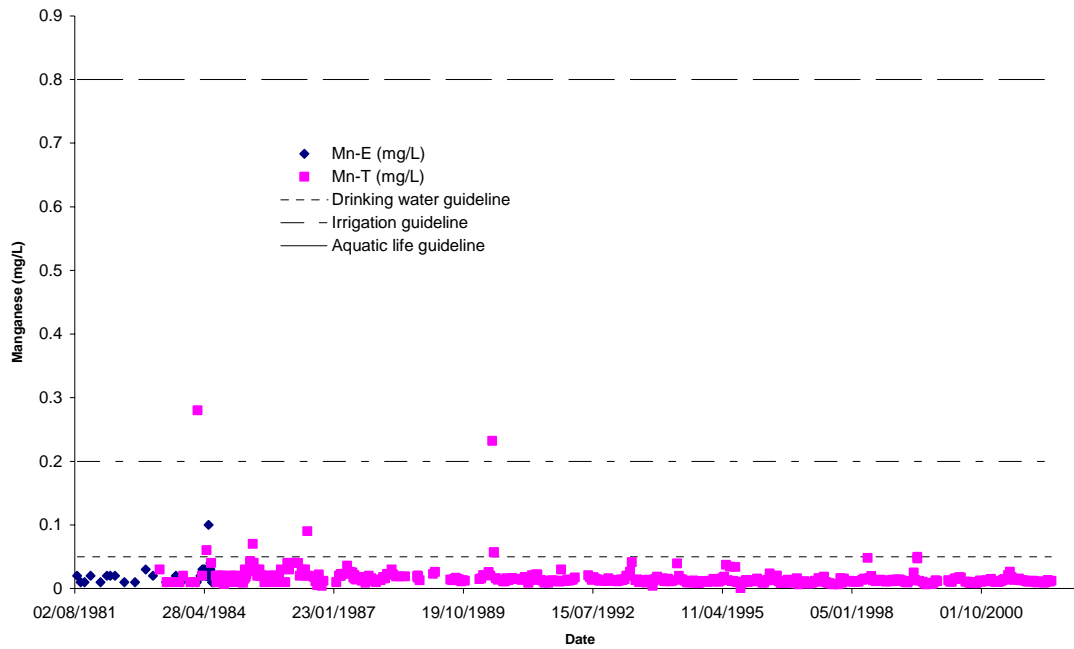
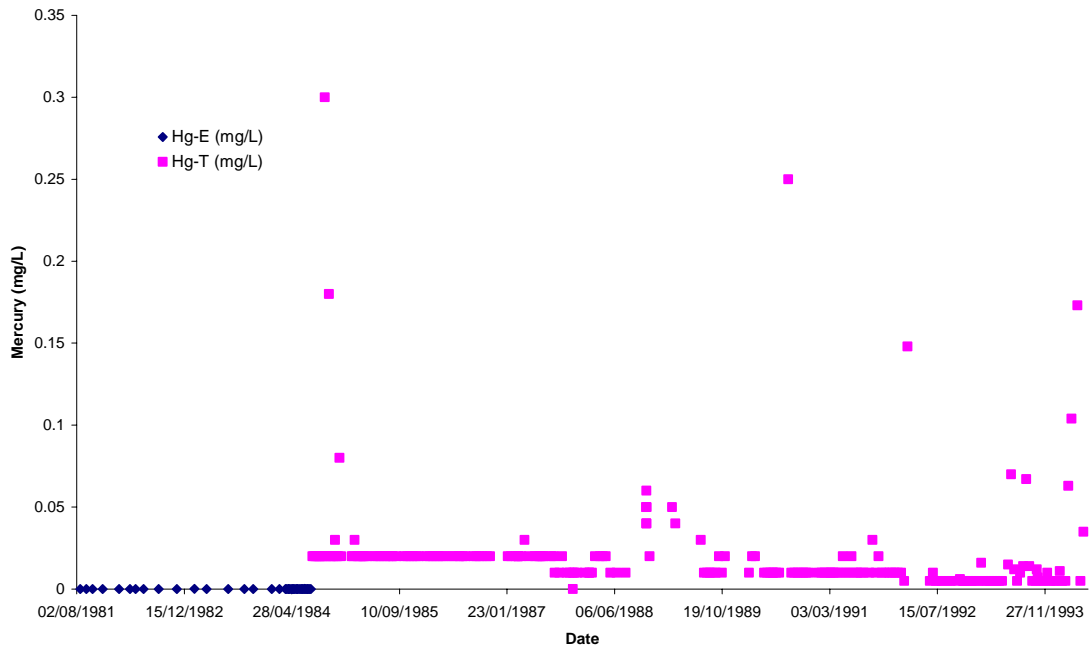


Figure 30. Okanagan River at Oliver - Mercury, Total and Extractable



Water Quality Assessment of the Okanagan River at Oliver, 1979-2002

Figure 31. Okanagan River at Oliver - Molybdenum, Total

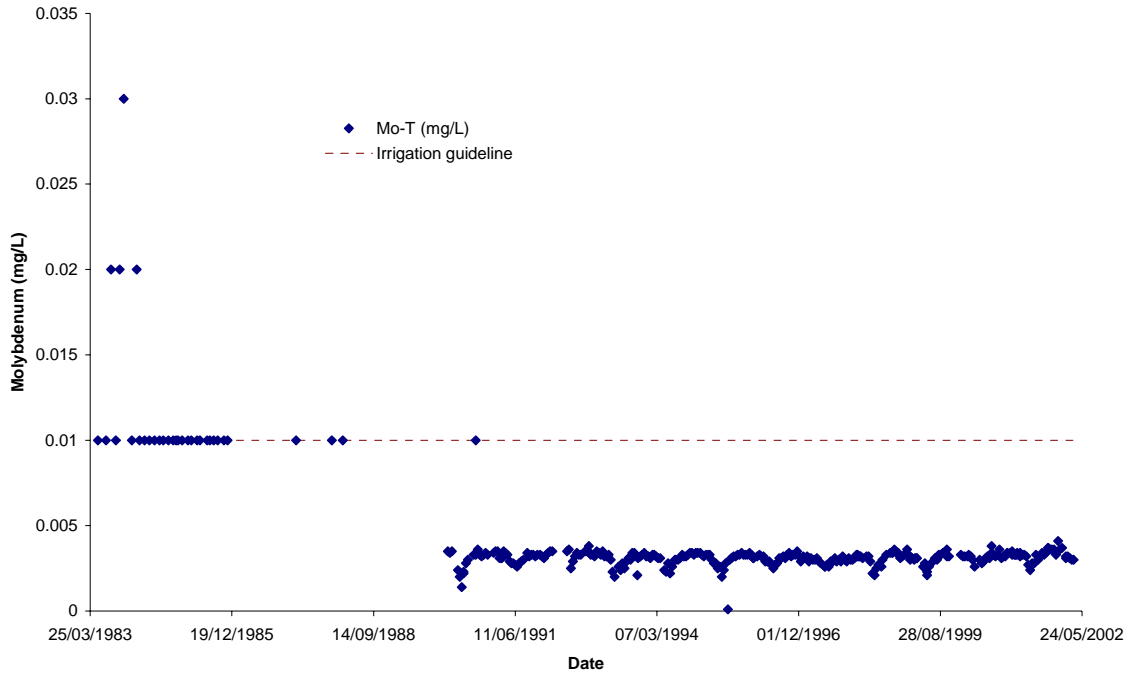
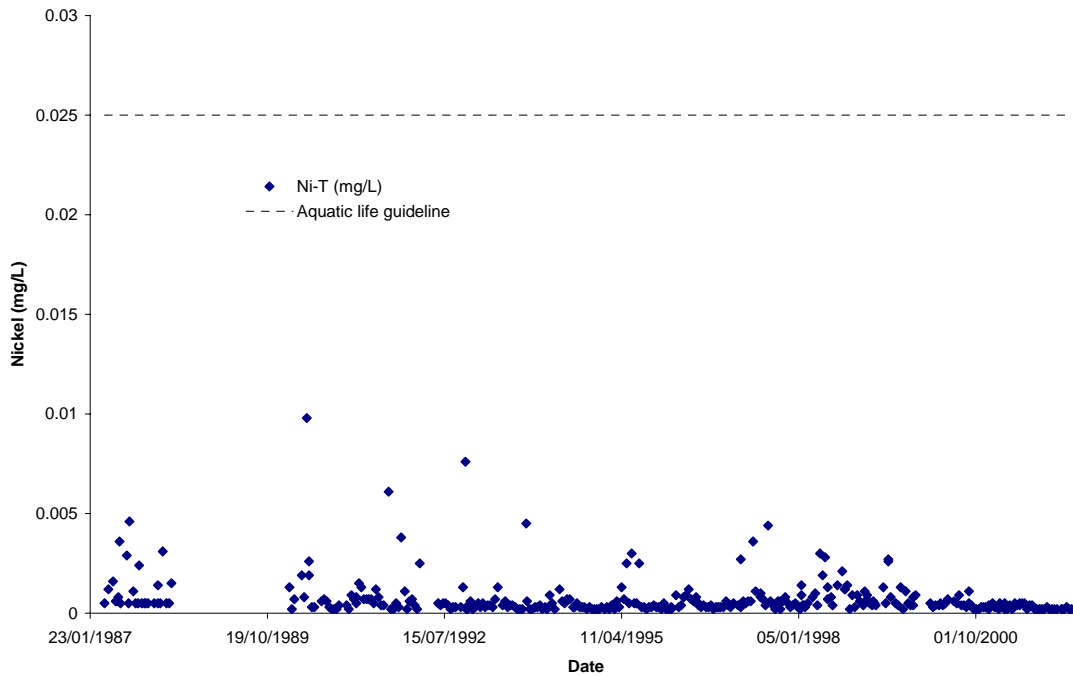


Figure 32. Okanagan River at Oliver - Nickel, Total



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Figure 33. Okanagan River at Oliver - Nitrogen, Total, Dissolved and Total Organic

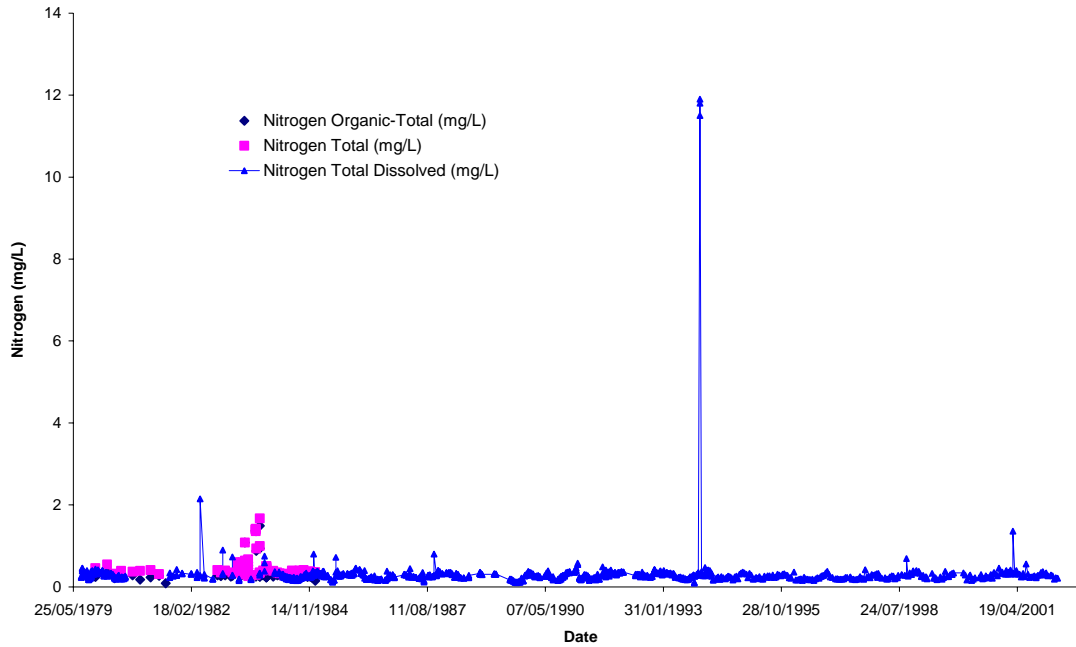
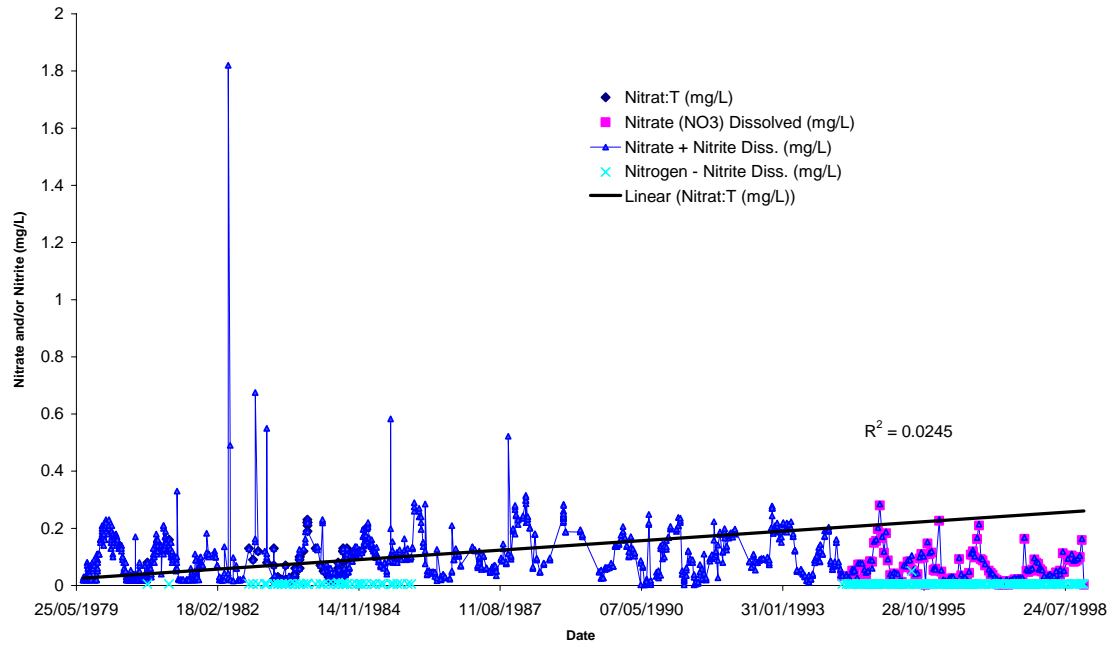


Figure 34. Okanagan River at Oliver - Nitrate, Nitrite



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Figure 35. Okanagan River at Oliver - pH

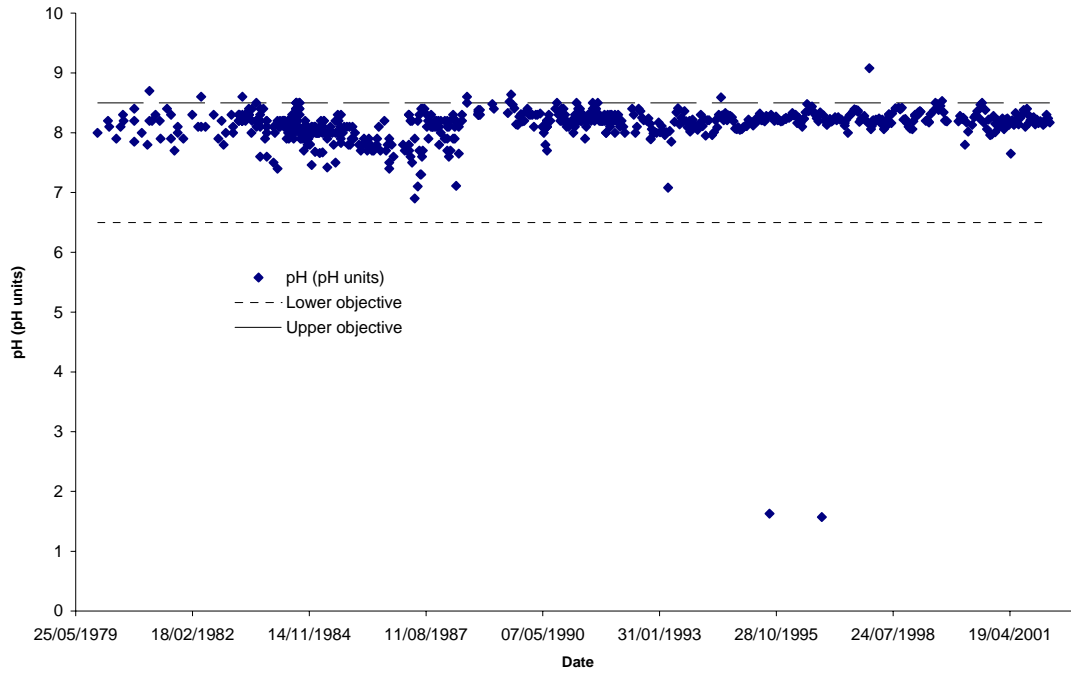
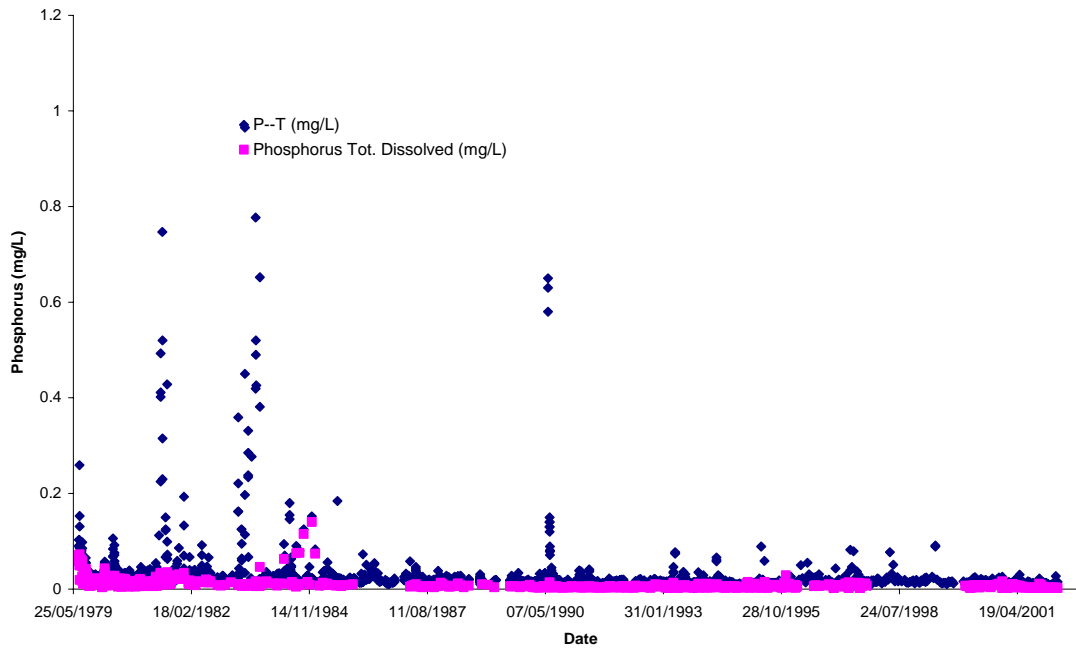


Figure 36. Okanagan River at Oliver - Phosphorus, Total and Dissolved



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Figure 37. Okanagan River at Oliver - Potassium, Dissolved and Extractable

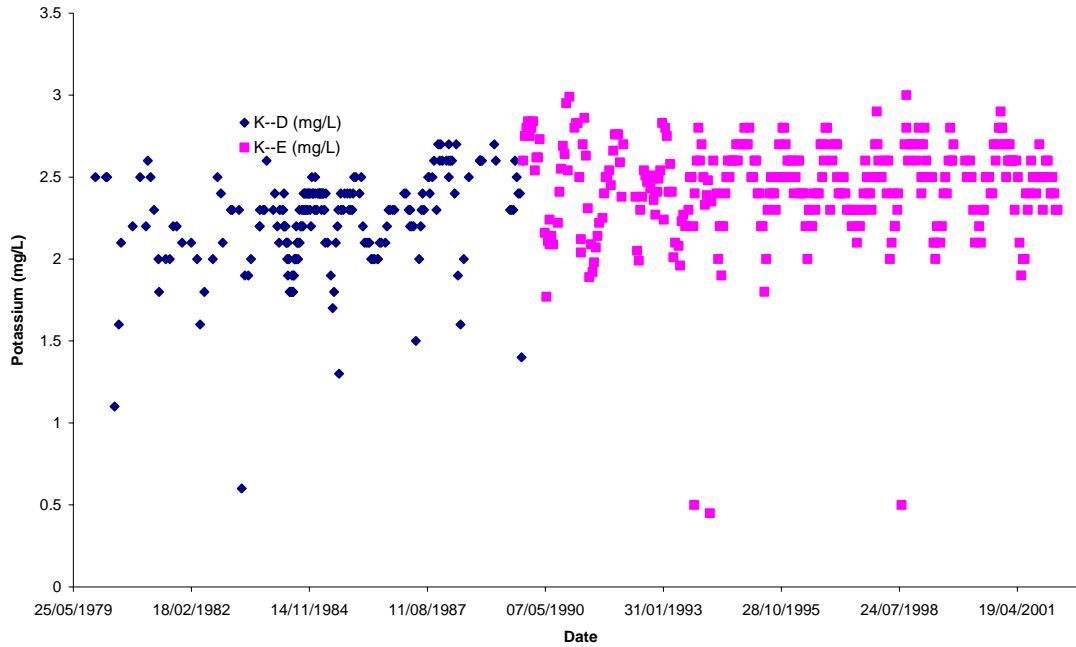


Figure 38. Okanagan River at Oliver - Residue, Non-Filterable

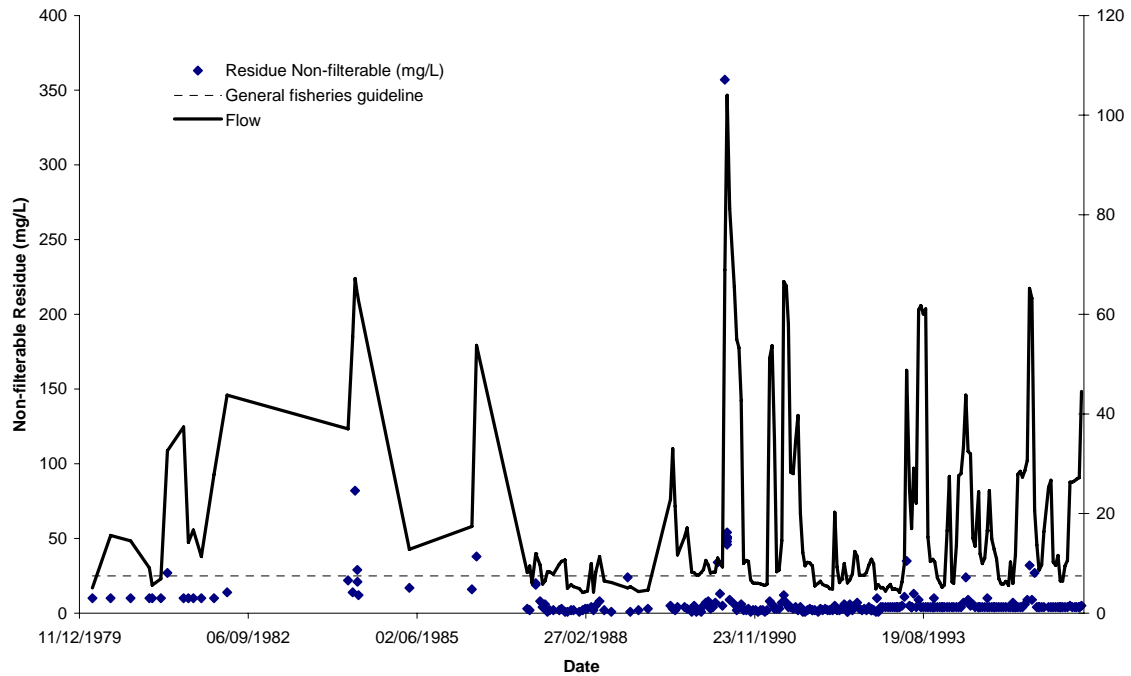


Figure 39. Okanagan River at Oliver - Selenium, Total and Extractable

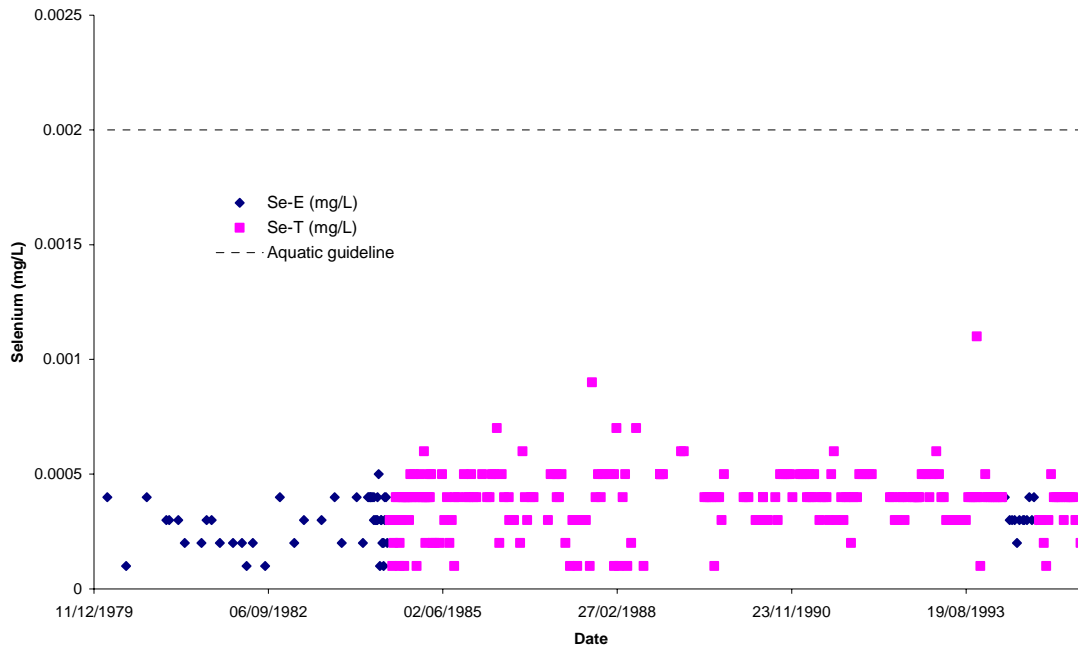
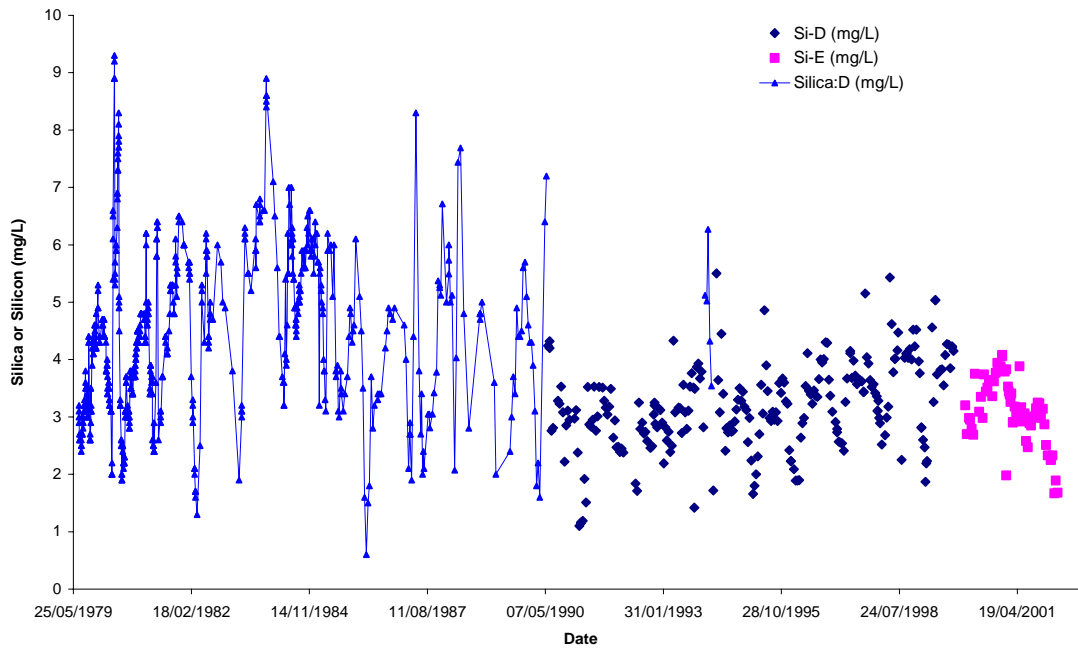


Figure 40. Okanagan River at Oliver - Silicon, Dissolved and Extractable, and Silica, Dissolved



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Figure 41. Okanagan River at Oliver - Silver, Total

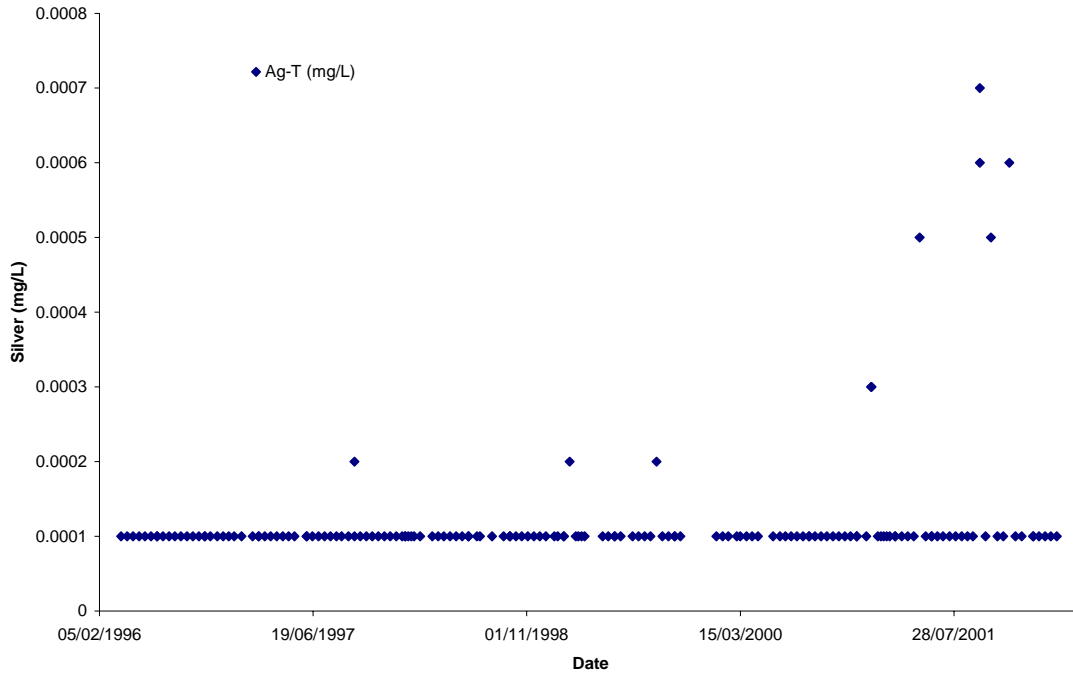
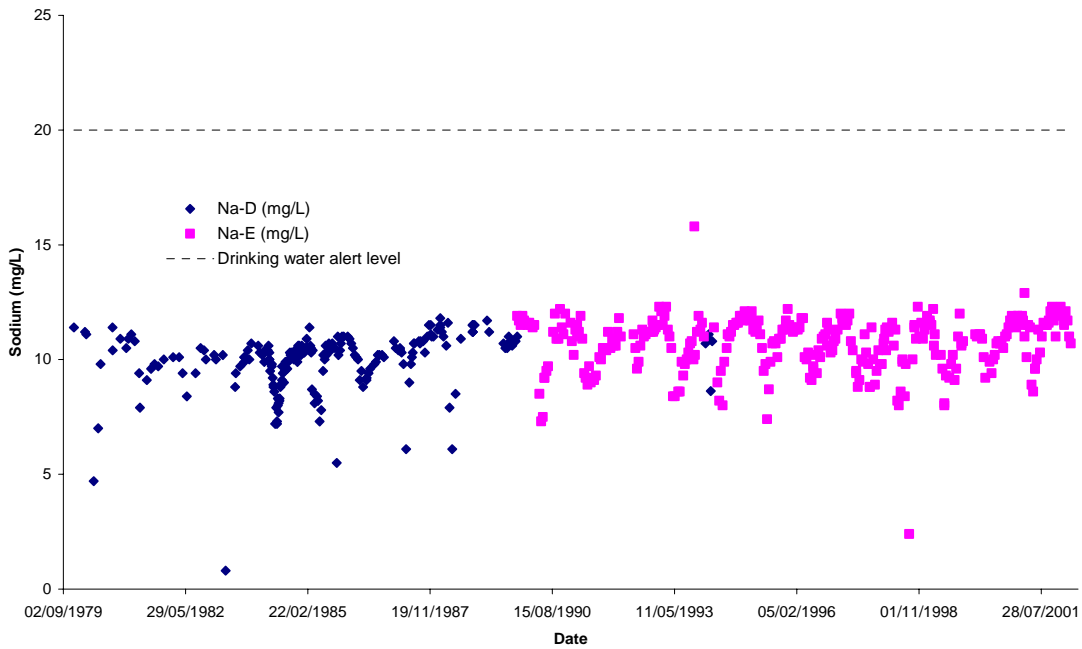


Figure 42. Okanagan River at Oliver - Sodium, Dissolved and Extractable



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Figure 43. Okanagan River at Oliver - Strontium, Total

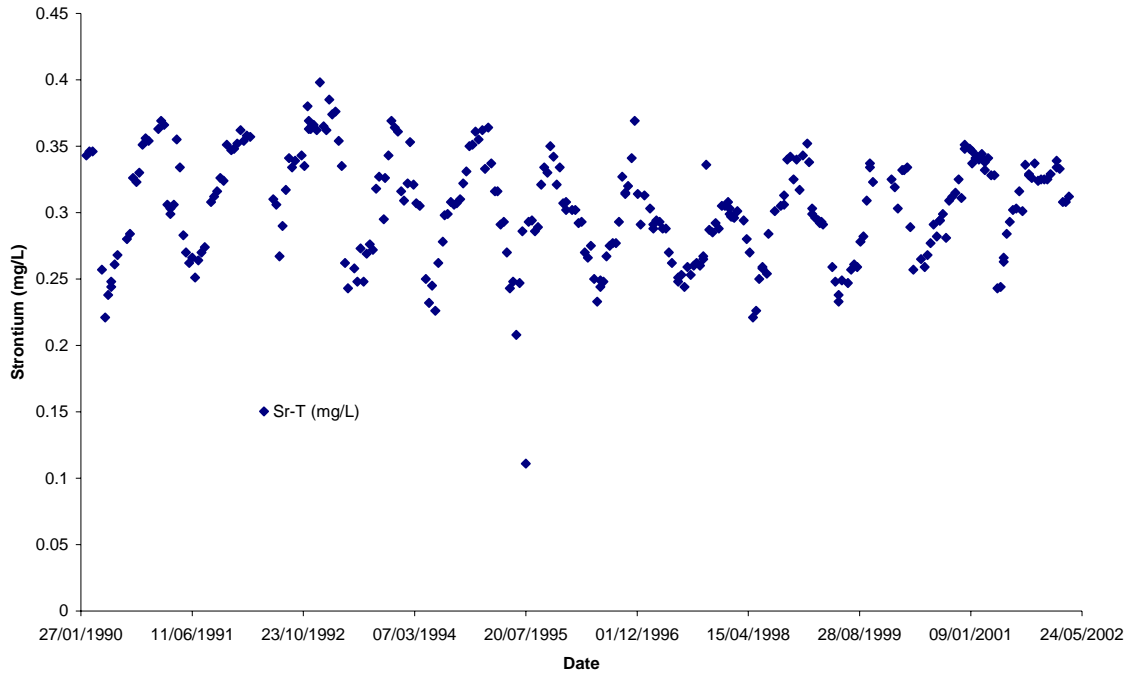
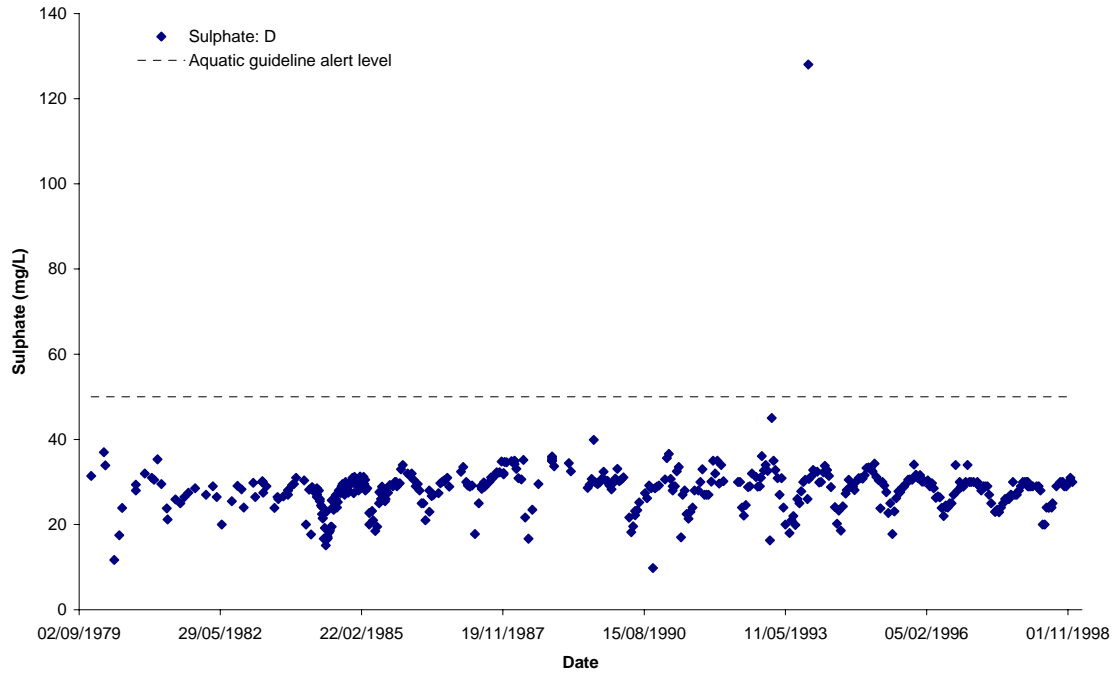


Figure 44. Okanagan River at Oliver - Sulphate, Dissolved



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Figure 45. Okanagan River at Oliver - Temperature, Water

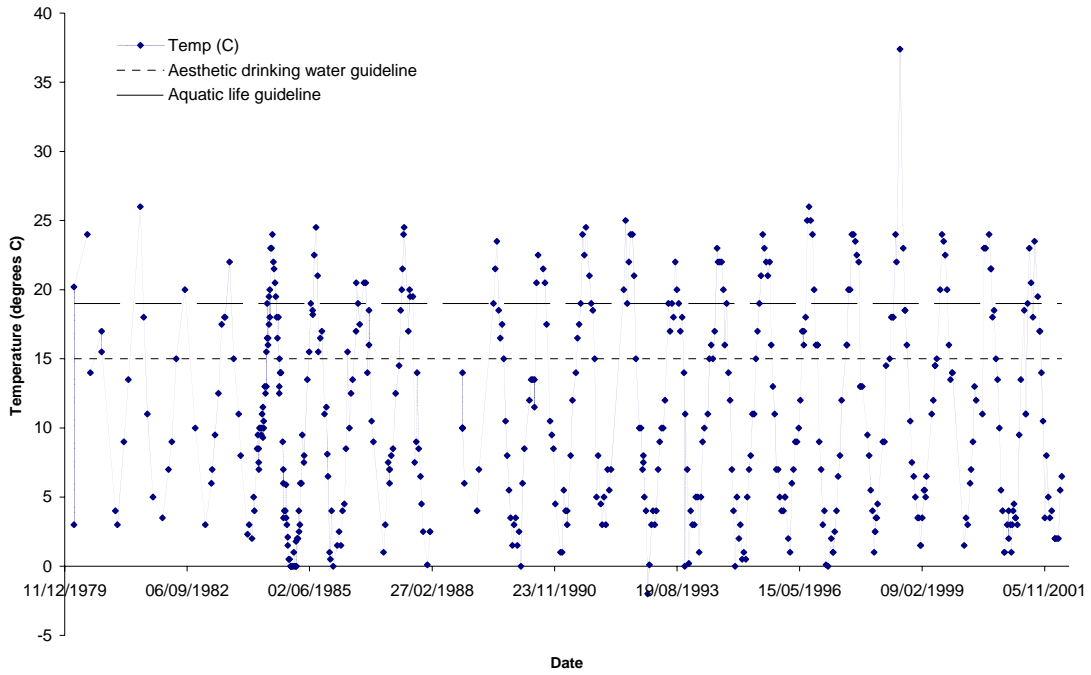
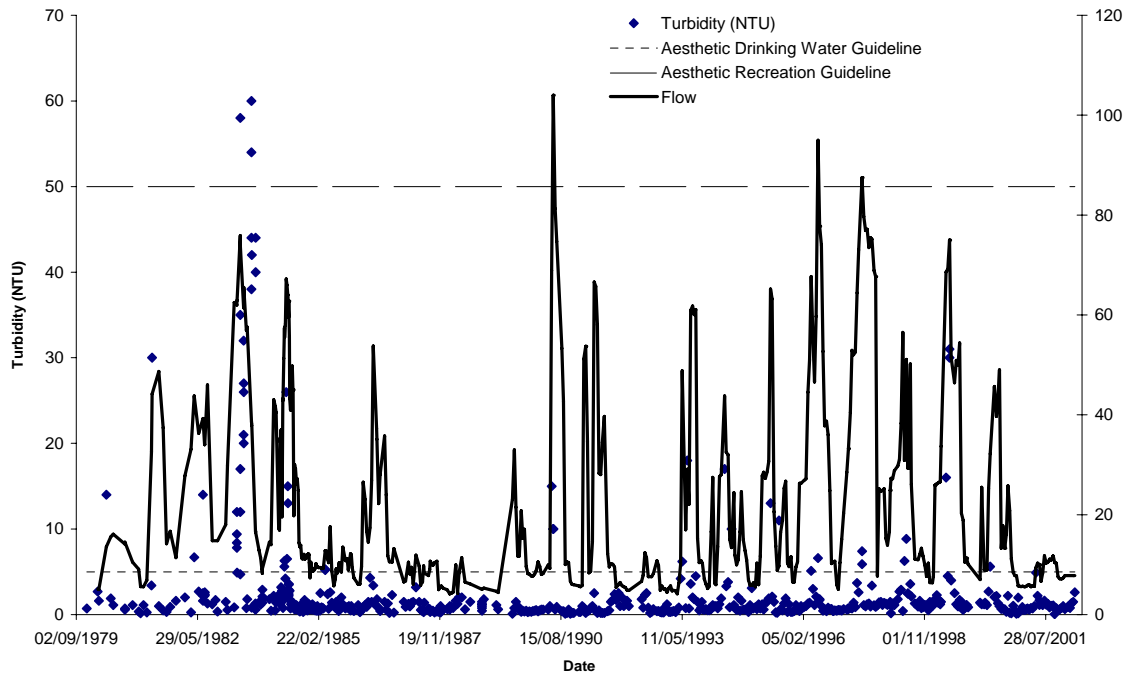


Figure 46. Okanagan River at Oliver - Turbidity and Flow



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Figure 47. Okanagan River at Oliver - Uranium, Total

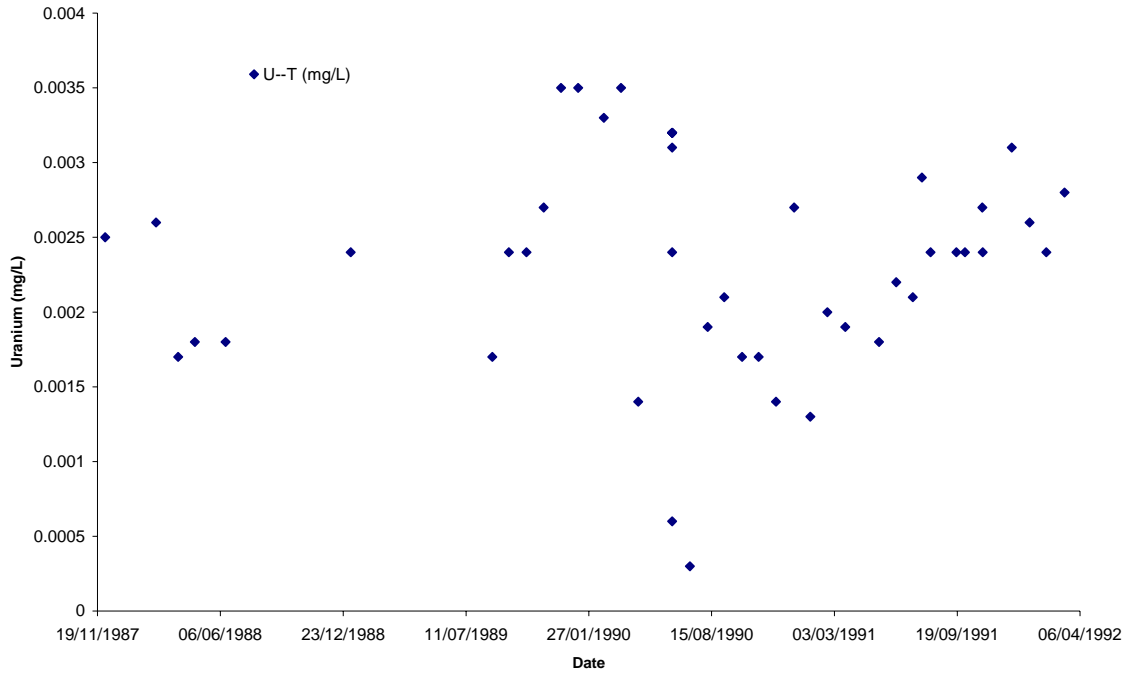
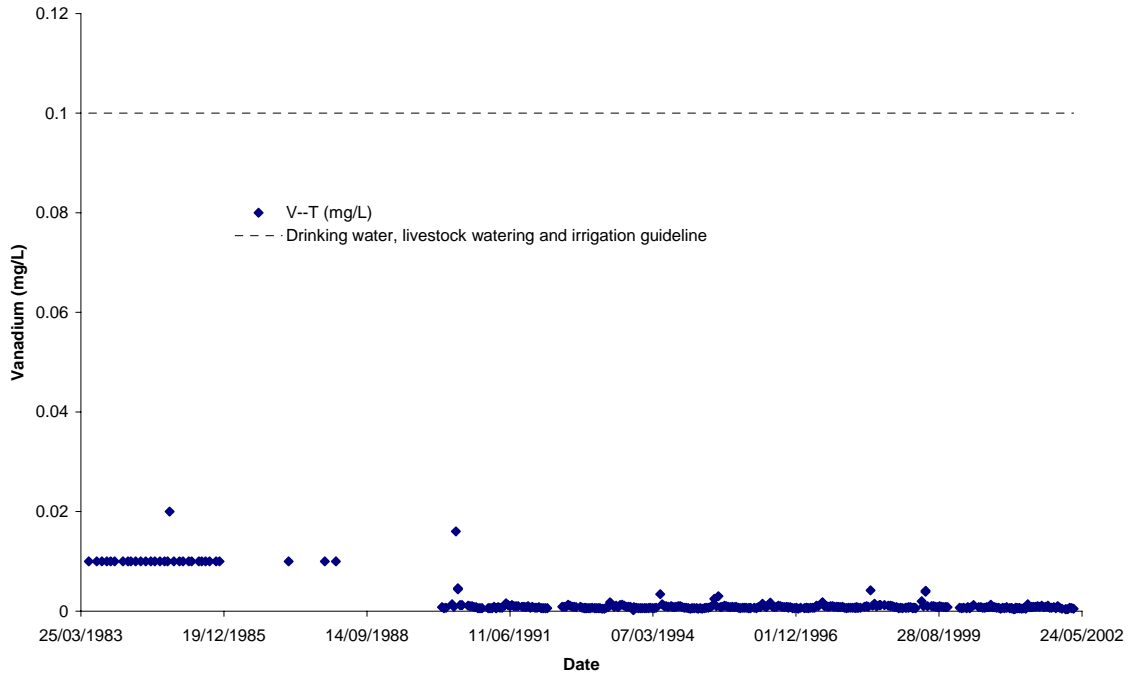


Figure 48. Okanagan River at Oliver - Vanadium, Total



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Figure 49. Okanagan River at Oliver - Zinc, Total and Extractable and Turbidity

