State Of Water Quality Of Liard River At Lower Crossing 1984-1994

Canada - British Columbia
Water Quality Monitoring Agreement

Water Quality section
Water Management Branch
Ministry of Environment, Lands and Parks

Monitoring and Systems Branch
Pacific and Yukon Region
Environment Canada

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Executive Summary

The Liard River is a major tributary of the Mackenzie River, flowing southeast from the Yukon into British Columbia, looping through northern B.C., and then flowing northeast into the Northwest Territories to the Mackenzie (Figure 1). Water quality is affected by mining and forestry.

There are three water quality stations on the Liard River: Upper Crossing near the Yukon-B.C. border, Lower Crossing at Liard River, B.C., and at Fort Liard in the Northwest Territories (Figure 1). This report assesses water quality data collected at the Lower Crossing monitoring station, located at Mile 496 on the Alaska Highway at Liard River, B.C. Water quality samples were collected between 1984 and 1994

by Environment Canada. Flow was measured at a Water Survey of Canada flow gauge at the water quality monitoring station.

We concluded that:

· There were no environmentally significant trends in water quality that could be identified through visual examination of the data.
· Total aluminum, cadmium, chromium, copper, iron, lead, manganese and zinc at times exceeded water quality criteria for aquatic life or drinking water due to high levels of suspended sediment during high river flow. These metals were probably not bio-available and would be removed by drinking water treatment needed to remove turbidity.
· Turbidity removal and disinfection are needed prior to drinking water use.
· The river had a low sensitivity to acid inputs.
· Hardness levels were generally within the optimum range for drinking water in the summer and above the optimum range in the winter.
· The water was cool enough to be aesthetically pleasing for drinking, but too cold for water-contact recreation.

We recommend that monitoring be terminated for the Liard River at Lower Crossing because there are no apparent water quality trends or concerns at this time.

Figure 1 Map of Liard River (Scale 1:3,300,000)

Authors

Jang, L. Water Quality Section, Water Management Branch, Ministry

of Environment, Lands and Parks, Victoria, B.C.

Pommen, L.W. Water Quality Section, Water Management Branch, Ministry

of Environment, Lands and Parks, Victoria, B.C.

Contributors

Boettger, B. Water Quality Consultant, Environmental Health Program, Public Health Protection Branch, Ministry of Health, Victoria, B.C.

Carmichael, B. Environmental Protection, Ministry of Environment, Lands and Parks, Omineca-Peace Region, Prince George, B.C.

Holms, G.B. Water Quality Section, Water Management Branch, Ministry

of Environment, Lands and Parks, Victoria, B.C.

Regnier, R. Monitoring Strategies Division, Monitoring and Systems Branch, Pacific and Yukon Region, Environment Canada, Vancouver, B.C.

Ryan, A. Monitoring Strategies Division, Monitoring and Systems Branch,

Pacific and Yukon Region, Environment Canada, Vancouver, B.C.

Introduction

The Liard River originates in the southern portion of the Yukon Territory (Figure 1). The river flows southeast across the British Columbia border, past the town of Liard River. Then, the Liard flows north across the Northwest Territories border to the confluence with the South Nahanni River and continues northeast, where it joins the Mackenzie River. The Kechika River comes from the south and meets the Liard 70 km upstream from the town of Liard River. Other major tributaries which are further downstream include the Fort Nelson and Petitot Rivers from the south. The Liard River is under ice from November to April.

There are three water quality monitoring stations on the Liard River (Upper Crossing in the Yukon, Lower Crossing in British Columbia, and Fort Liard in the Northwest Territories - see Figure 1). The Lower Crossing monitoring station is located at Mile 496 of the Alaska Highway at the lower Liard bridge crossing. The water quality of the other two stations is discussed in two separate reports (Jang & Pommen, 1996a & 1996b). Mining activities on the Liard are concentrated upstream near the Dease and Kechika Rivers. Forestry in the Liard River basin occurs in the Yukon and British Columbia. Plans for a hydroelectric project downstream from the town of Liard River and near the Beaver River confluence exist, but are not expected to proceed within the next twenty years (MacDonald, 1993).

Data for this report are from sampling by Environment Canada, between 1984 and 1994, and are stored under ENVIRODAT station number BC10BE0005. The water quality indicators are plotted in Figures 3 to 42. Water Survey of Canada operated a flow gauge at the water quality monitoring station (site number BC10BE001). The drainage area at the flow station is 104,000 km^2. Flow data are graphed in Figure 2.

Quality Assurance

The water quality graphs were inspected and erroneous values were removed. There were questionable values for aluminum and pH. Total chromium, copper, lead and zinc had high values between 1986 and 1991 due to the failure of preservative vial lid liners which resulted in sample contamination. Mercury data were not plotted because all detectable values were likely due to contamination as well (Pommen, 1994). Values for pH between 1986 and 1988 were much lower than the rest of the pH data due to laboratory method problems at that time. Quality assurance issues are discussed in further detail in the next section.

State of the Water Quality

The state of the water quality was judged by comparing values to the Ministry of Environment, Lands and Parks' Approved and Working Criteria for Water Quality (Nagpal *et al.*, 1995). Indicators not discussed below met their criteria and did not display any noticeable trends. These include: arsenic, barium, beryllium, chloride, cobalt, fluoride, lithium, magnesium, molybdenum, nickel, nitrate/nitrite, total dissolved nitrogen, pH, total phosphorus, potassium, filterable residue, fixed filterable residue, fixed non-filterable residue, selenium, silica, sodium, specific conductivity, strontium, and sulphate.

Flow (Figure 2) values were highest during spring freshet (May-July). Peak flow values were similar most years except for lower values in 1989 and 1991.

Total alkalinity (Figure 3) and **calcium** (Figure 9) concentrations indicate a low sensitivity to acid inputs.

Total aluminum (Figure 4) values exceeded the 5 mg/L total aluminum criterion for wildlife, livestock and irrigation only once (June 16, 1992) during peak flow and suspended sediment. Peak aluminum values corresponded to peak non-filterable residue and turbidity. This suggests that the aluminum was in a particulate form and probably not biologically available and would be removed by the turbidity removal needed before drinking. Dissolved aluminum should also be measured for direct comparison to criteria for drinking water and aquatic life.

Total cadmium (Figure 8) had minimum detectable limits (0.0001 mg/L & 0.001 mg/L) 2 to 33 times above the aquatic life criteria (0.00003 to 0.00005 mg/L). All values between 1986 and 1991 are questionable due to suspected preservative vial contamination. Since 1991, peak cadmium values corresponded to peak non-filterable residue and turbidity. This indicates that the cadmium was in a particulate form and probably not biologically available. To evaluate the aquatic life criteria accurately, the minimum detectable limit should be lowered to at least one-tenth of the lowest criterion, and dissolved cadmium should also be measured.

Total chromium (Figure 11) values between 1990 and 1991 are suspect due to preservative vial contamination. Since then, 45% of the values have exceeded the 0.002 mg/L criterion for phyto- and zoo-plankton. High chromium values corresponded to high non-filterable residue and turbidity. This indicates that the chromium was in a particulate form and probably not biologically available.

Apparent colour (Figure 13) met the 100-unit recreation (maximum) criterion except on one occasion (May 22, 1990). Also, the 15-unit drinking water and recreation criterion was met at least 60% of the time. All criteria are given as true colour values, where turbidity is removed before measurement. High apparent colour values occurred in samples with high turbidity, and thus true colour would have been much lower. True colour should be measured to compare the data to the criteria effectively.

Total copper (Figure 14) values were high due to preservative vial contamination between 1986 and 1991. Between 1991 and 1994, one value (June 16, 1992) exceeded the upper (0.008 mg/L) aquatic life criterion, and 41% of the values exceeded the lower (0.003 mg/L) aquatic life criterion. High copper and non-filterable residue and turbidity occurred together. This indicates that the copper was in a particulate form and probably not biologically available.

Hardness (Figure 16) values were within the optimum range for drinking water (80-100 mg/L as $CaCO_3$) 36% of the time. Sixty-one percent of the values were above this range. Lowest hardness values took place in the summer and highest values occurred in the winter.

Total iron (Figure 17) values exceeded the 5 mg/L criterion for irrigation 7% of the time, while the 0.3 mg/L drinking water and aquatic life criterion was exceeded 77% of the time. High values of iron corresponded with high non-filterable residue and turbidity. This indicates that the lead was in a particulate form and probably not biologically available and would be removed by the turbidity removal needed before drinking.

Total lead (Figure 18) exhibited high values between 1986 and 1991 due to preservative vial contamination. Since then, the aquatic life criterion was exceeded once (June 16, 1992) when non-filterable residue and turbidity were high. This indicates that the lead was in a particulate form and probably not biologically available.

Total manganese (Figure 21) values exceeded the 0.2 mg/L criterion for irrigation once (June 16, 1992). Also, the 0.1 mg/L criterion for aquatic life was exceeded 9% of the time, and the 0.05 mg/L criterion for drinking water was exceeded 27% of the time. High manganese and non-filterable residue and turbidity occurred together. This indicates that the manganese was in a particulate form and probably not biologically available and would be removed by the turbidity removal needed before drinking.

Non-filterable residue (Figure 30) values exceeded the 25 mg/L criterion for good fisheries 71% of the time due to high flows during freshet. The patterns of non-filterable residue and turbidity (Figure 41) were nearly identical.

Water temperature (Figure 40) exceeded the 15°C upper aesthetic limit for drinking water and the lower limit for recreation 6% of the time. This means that the water was cool enough to be aesthetically pleasing for drinking, but too cold for water-contact recreation such as swimming.

Turbidity (Figure 41) values exceeded the 50 NTU criterion for recreation 7% of the time due to high flows in spring freshet. The 5 NTU aesthetics criterion for drinking water was exceeded 69% of the time, and the 1 NTU health criterion for drinking water was exceeded 87% of the time. Turbidity removal and disinfection are needed prior to drinking.

Total zinc (Figure 42) exhibited high values between 1986 and 1991 due to suspected preservative vial contamination. Since 1991, one value (June 16, 1992) exceeded the 0.03 mg/L fish and invertebrates criterion and the 0.015 mg/L algae criterion. Non-filterable residue and turbidity were high then, indicating that the zinc was in a particulate form and probably not biologically available.

Conclusions - State of Water Quality

· There were no environmentally significant trends in water quality that could be identified through visual examination of the data.
· Total aluminum, cadmium, chromium, copper, iron, lead, manganese and zinc at times exceeded water quality criteria for aquatic life or drinking water due to high levels of suspended sediment during high river flow. These metals were probably not bio-available and would be removed by drinking water

treatment needed to remove turbidity.
· Turbidity removal and disinfection are needed prior to drinking water use.
· The river had a low sensitivity to acid inputs.
· Hardness levels were generally within the optimum range for drinking water in the summer and above the optimum range in the winter.
· The water was cool enough to be aesthetically pleasing for drinking, but too cold for water-contact recreation.

Recommendations for Water Quality Management

Remediation

· No remedial activities appear to be necessary at this time.

Monitoring

We recommend that monitoring be terminated for the Liard River at Lower Crossing because there are no apparent water quality trends or concerns at this time.

Figure 2 Flow

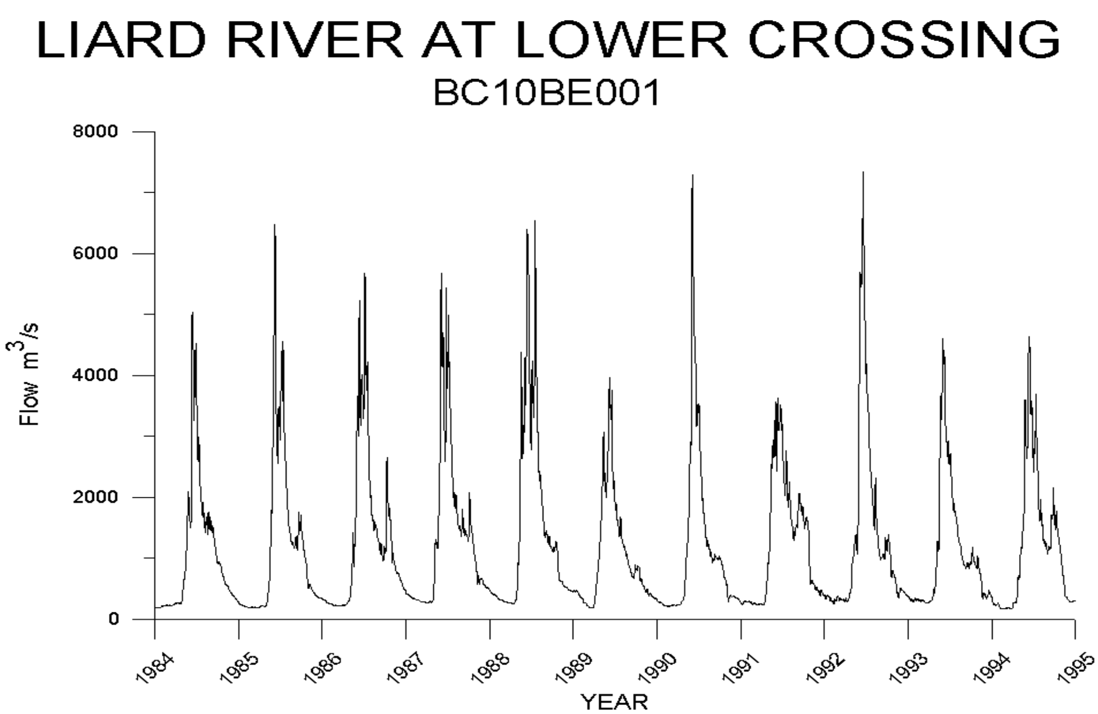


Figure 3 Total Alkalinity

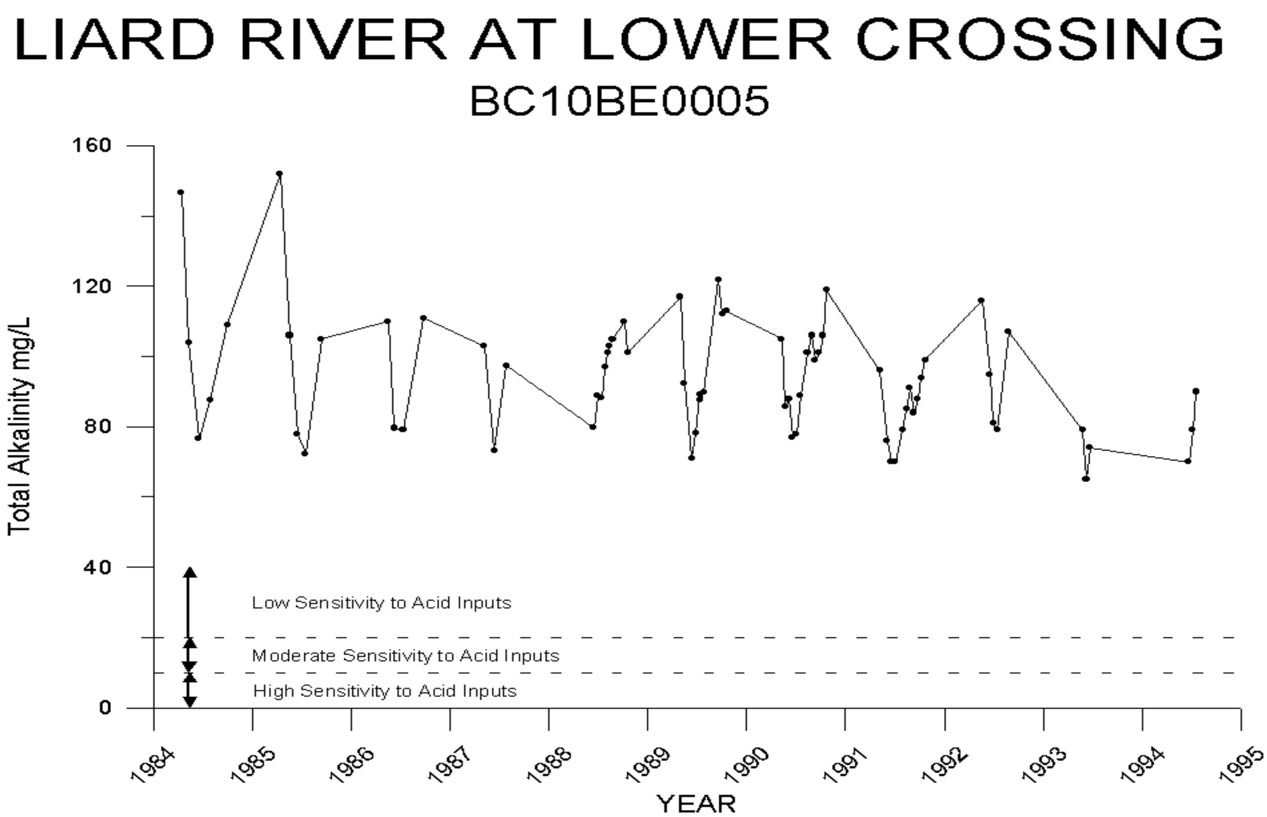


Figure 4 Total Aluminum

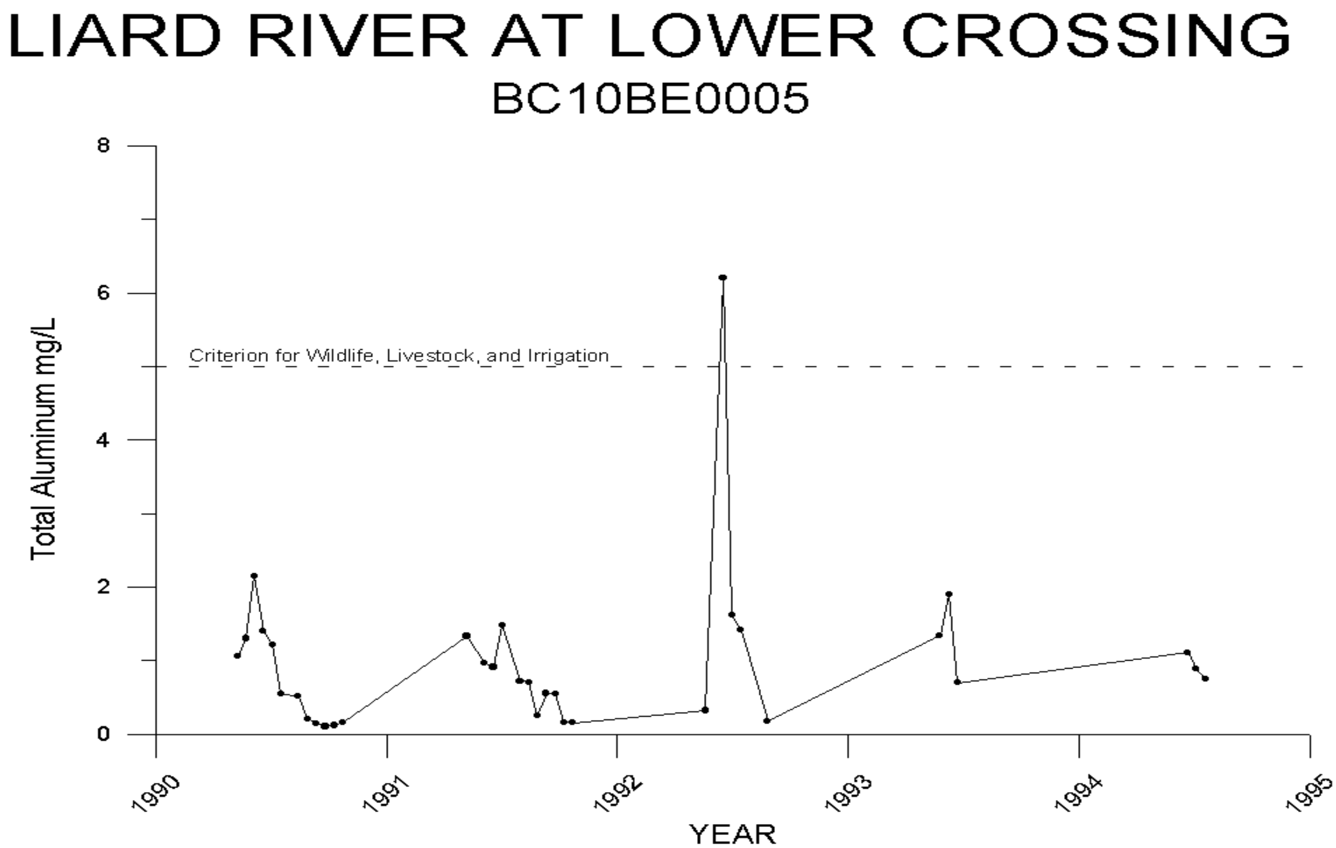


Figure 5 Total Arsenic

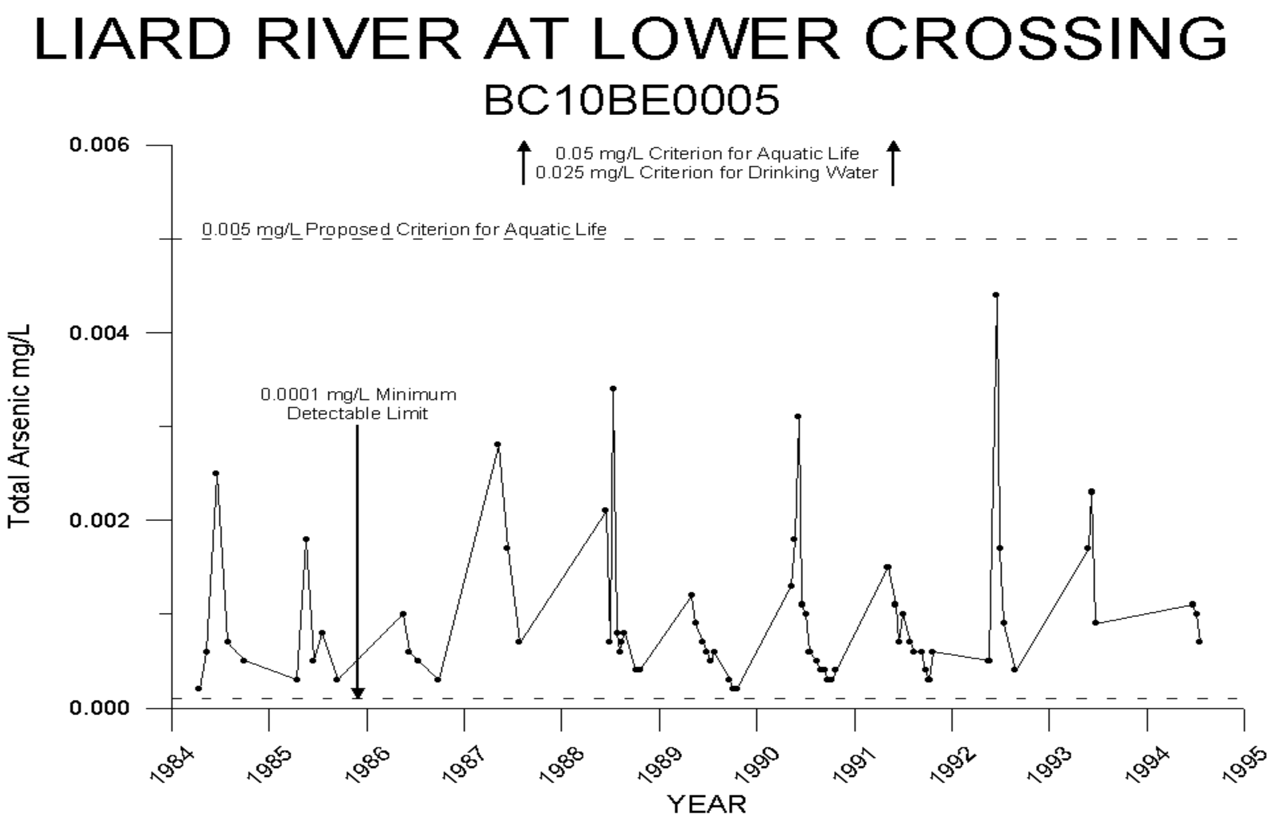


Figure 6 Total Barium

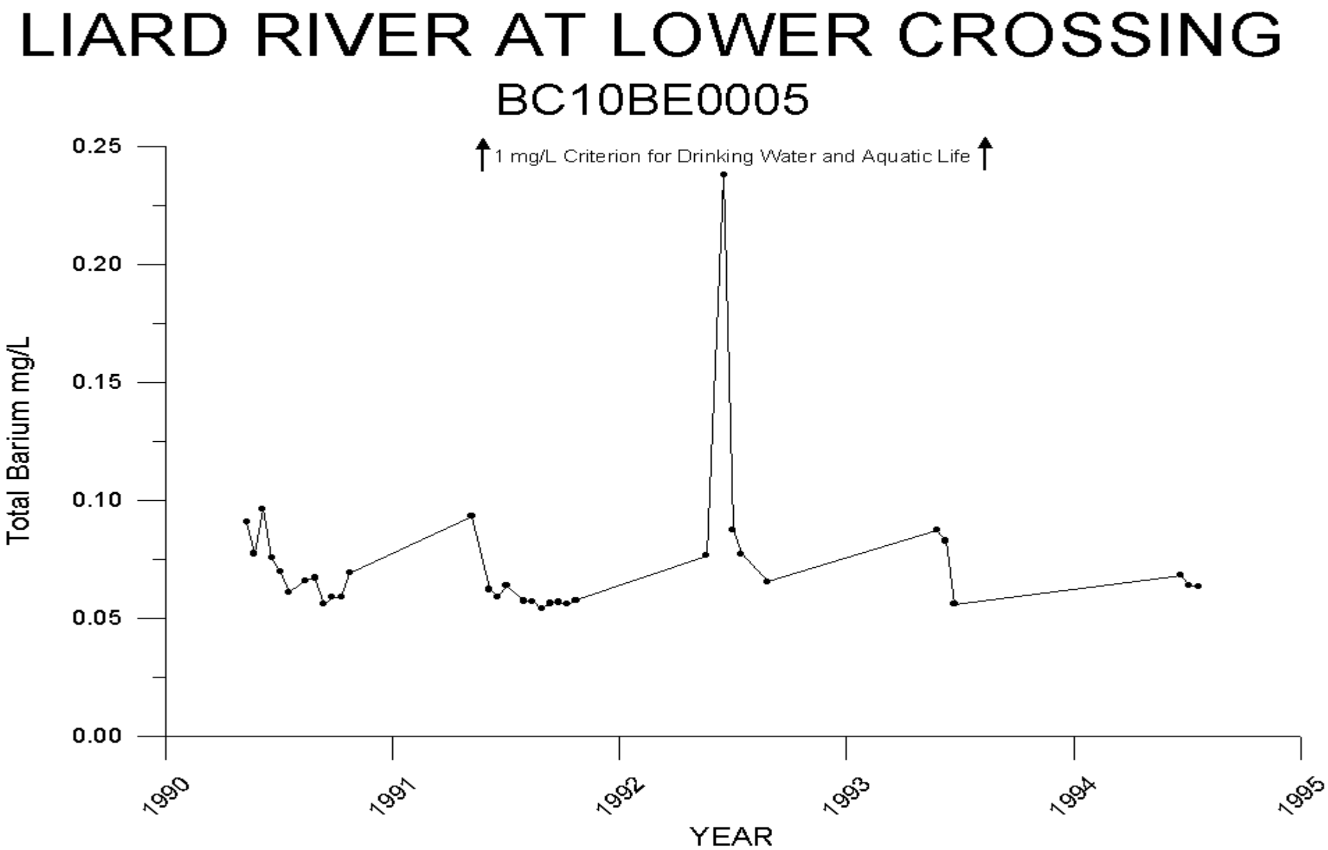


Figure 7 Total Beryllium

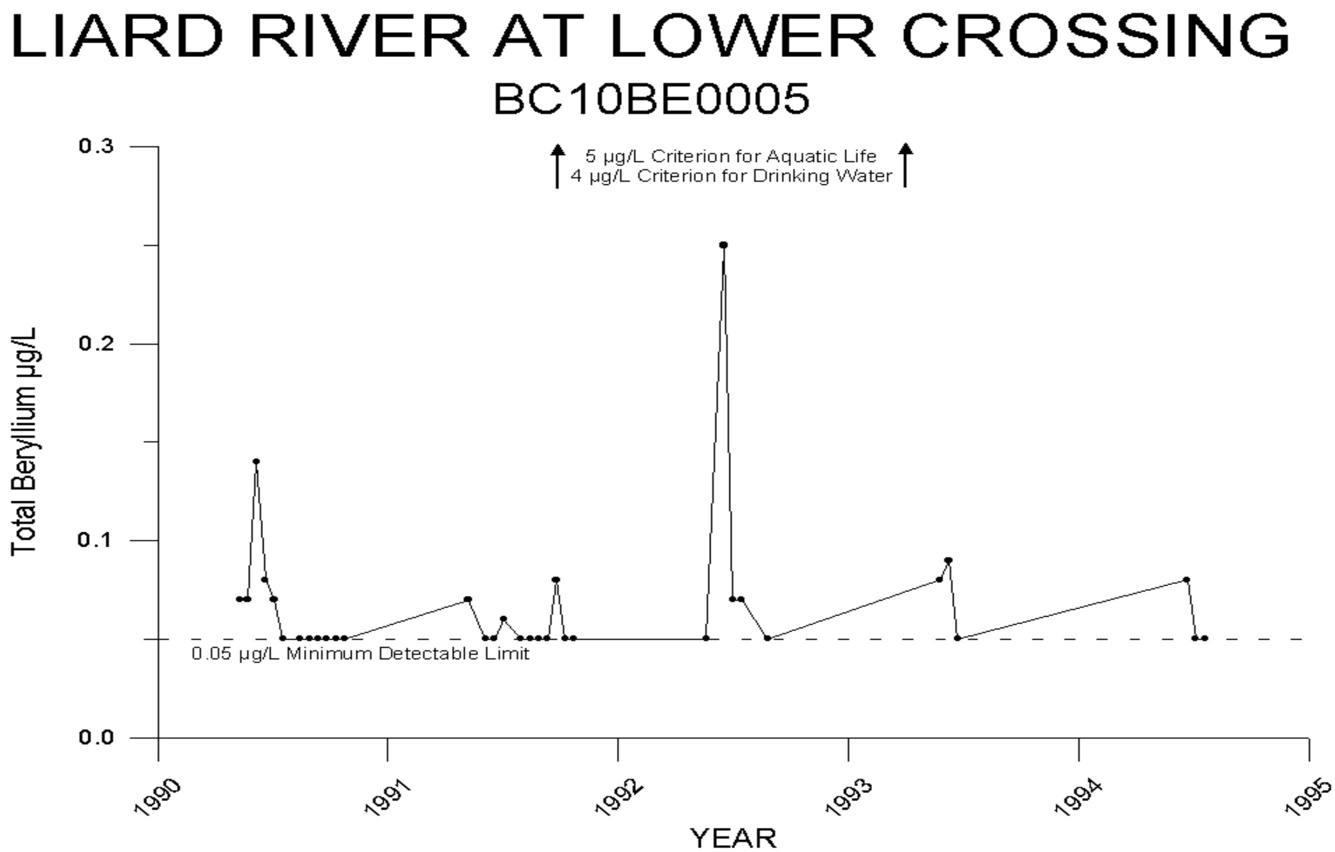


Figure 8 Total Cadmium

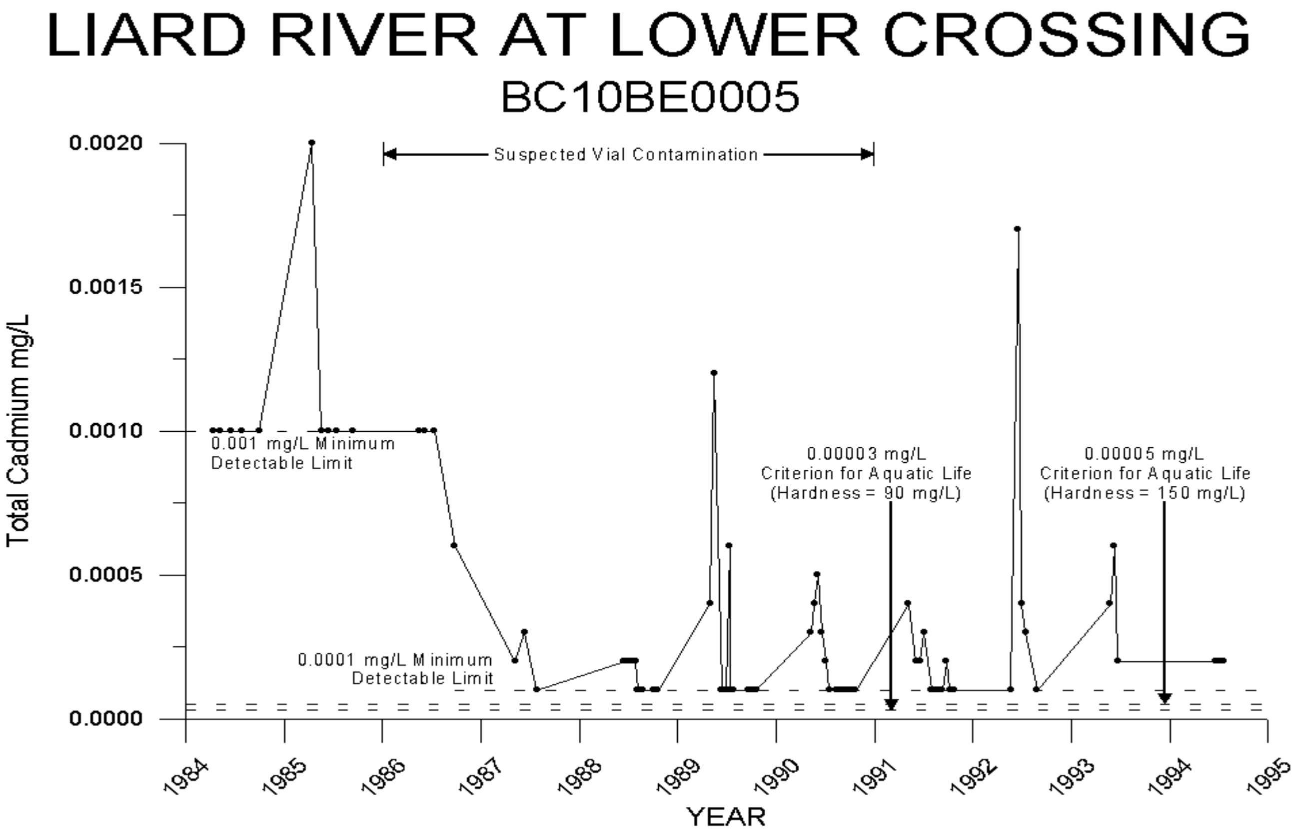


Figure 9 Calcium

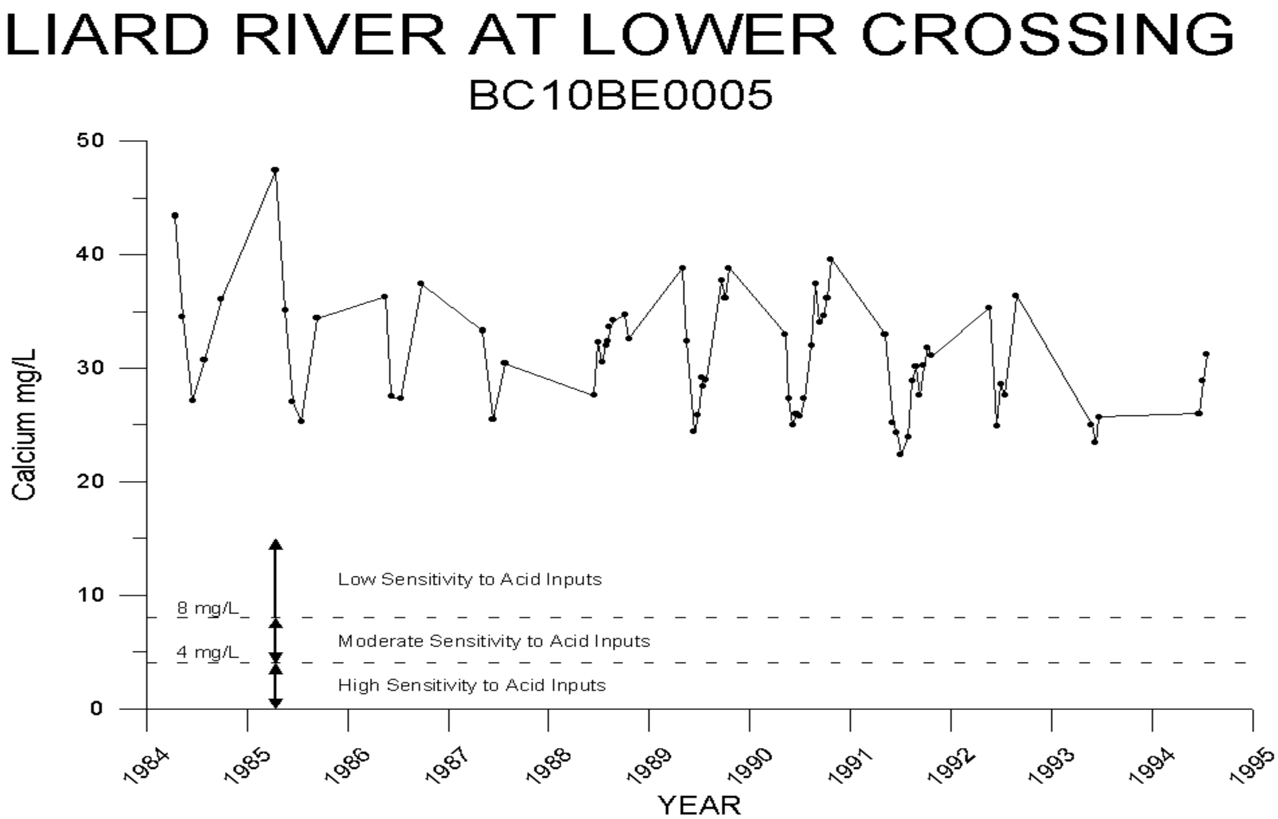


Figure 10 Dissolved Chloride

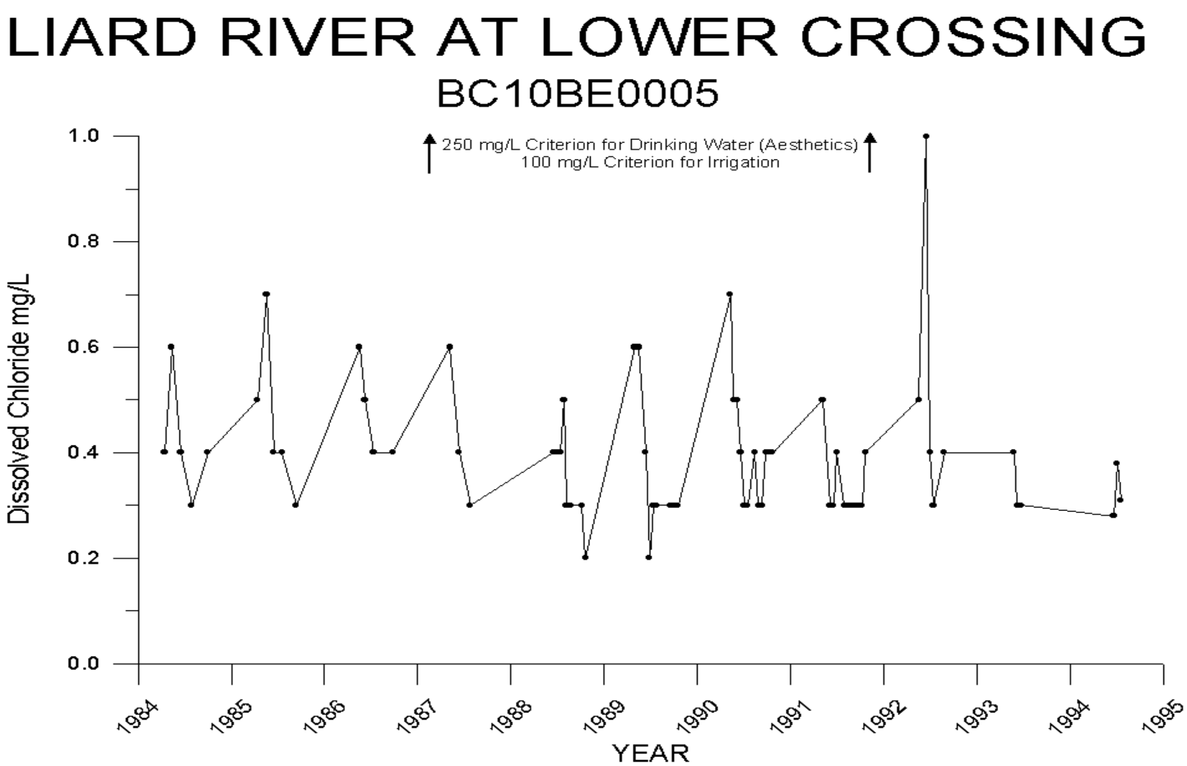


Figure 11 Total Chromium

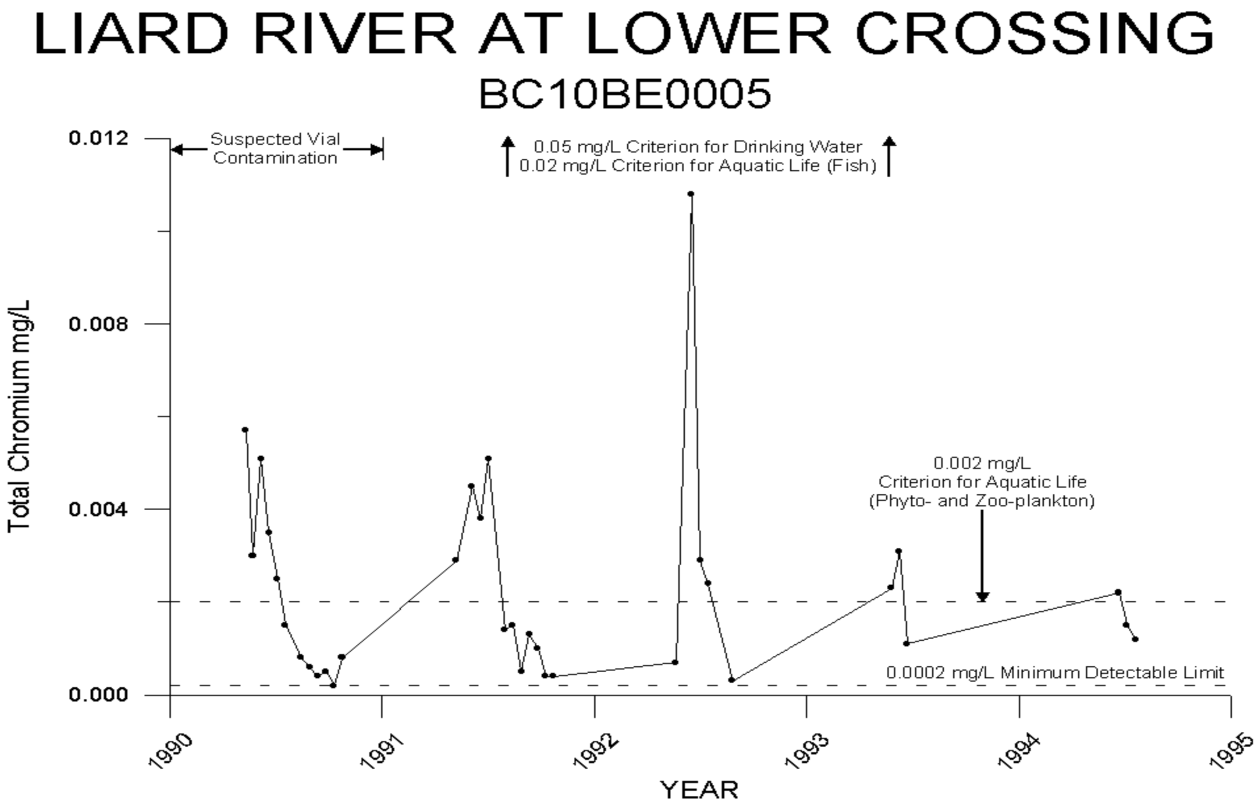


Figure 12 Total Cobalt

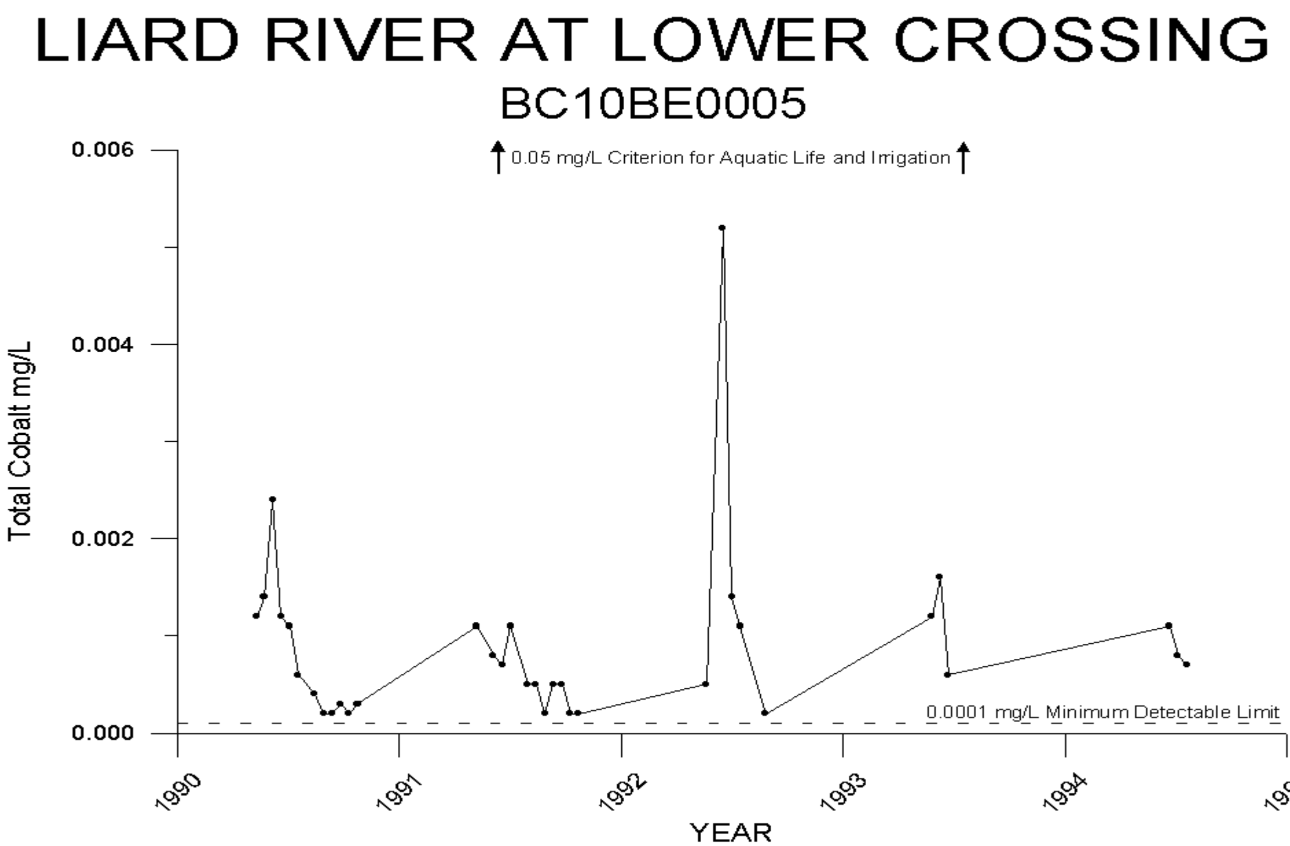


Figure 13 Apparent Colour

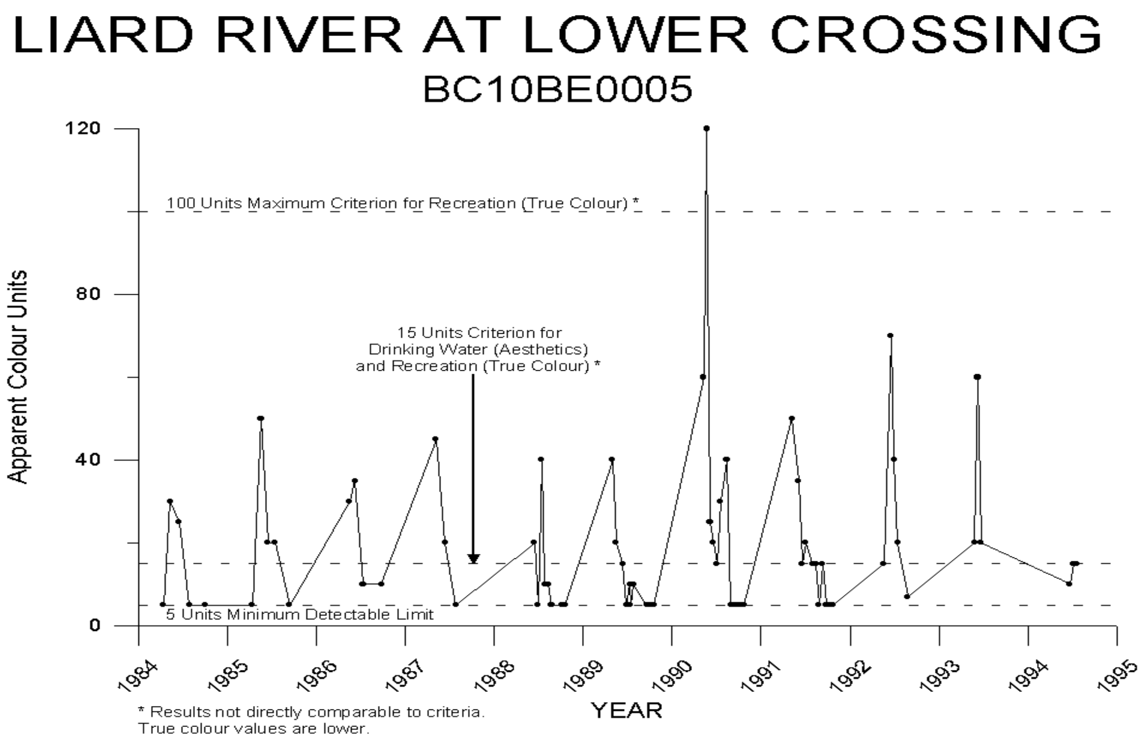


Figure 14 Total Copper

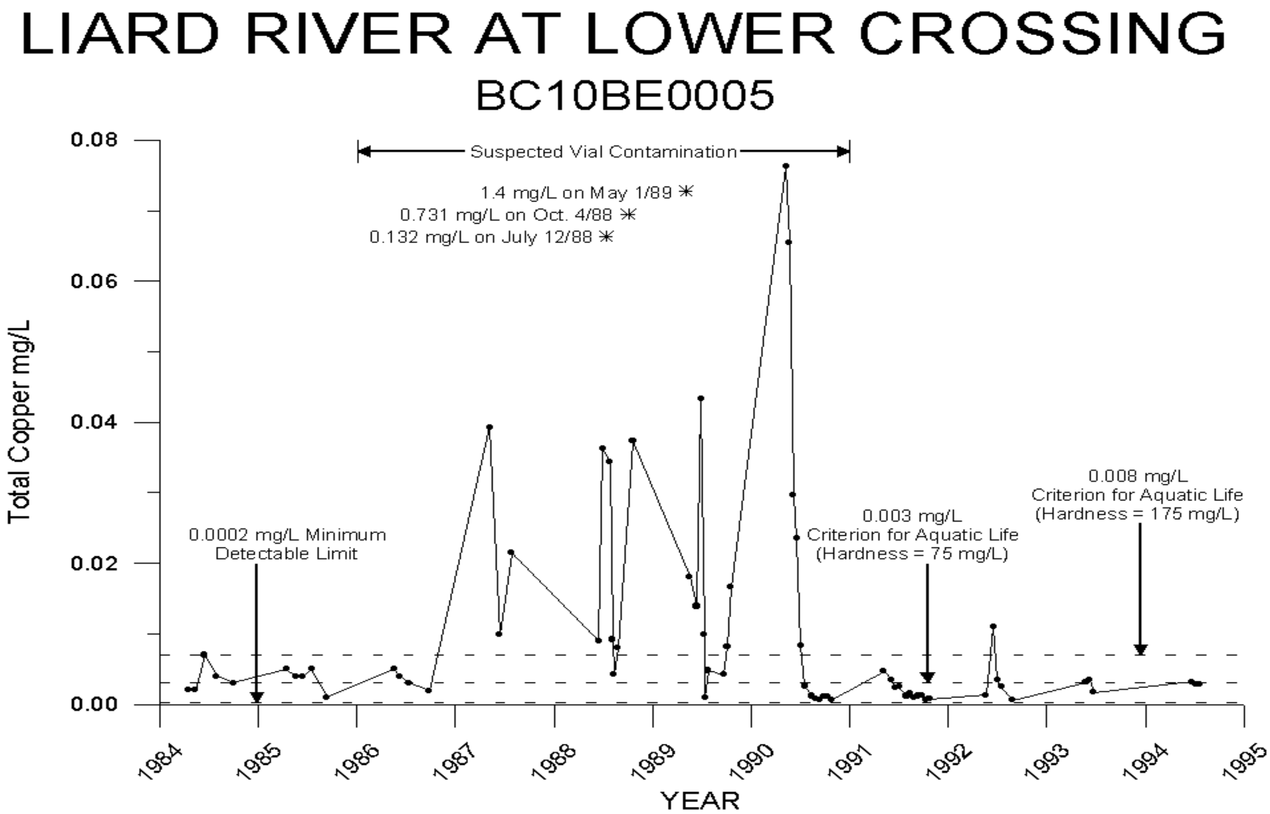


Figure 15 Dissolved Fluoride

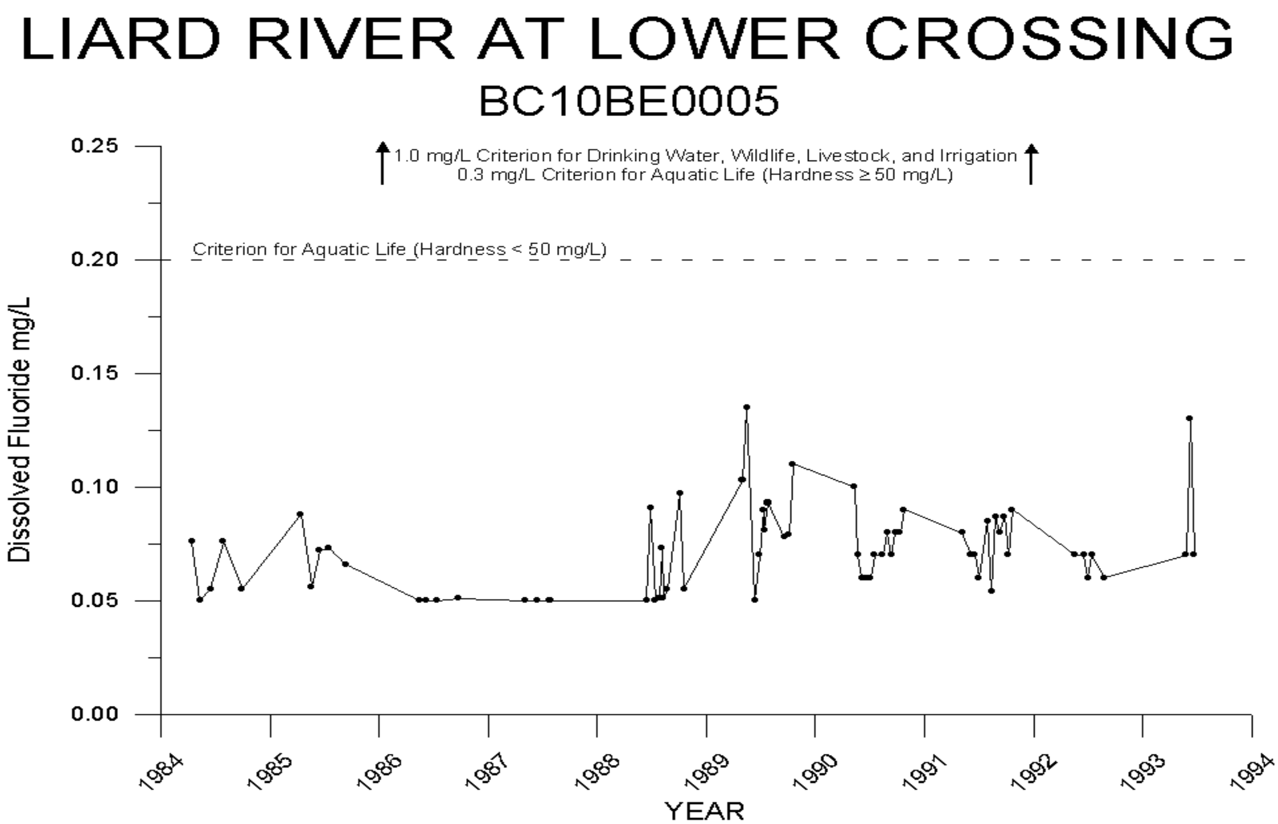


Figure 16 Hardness

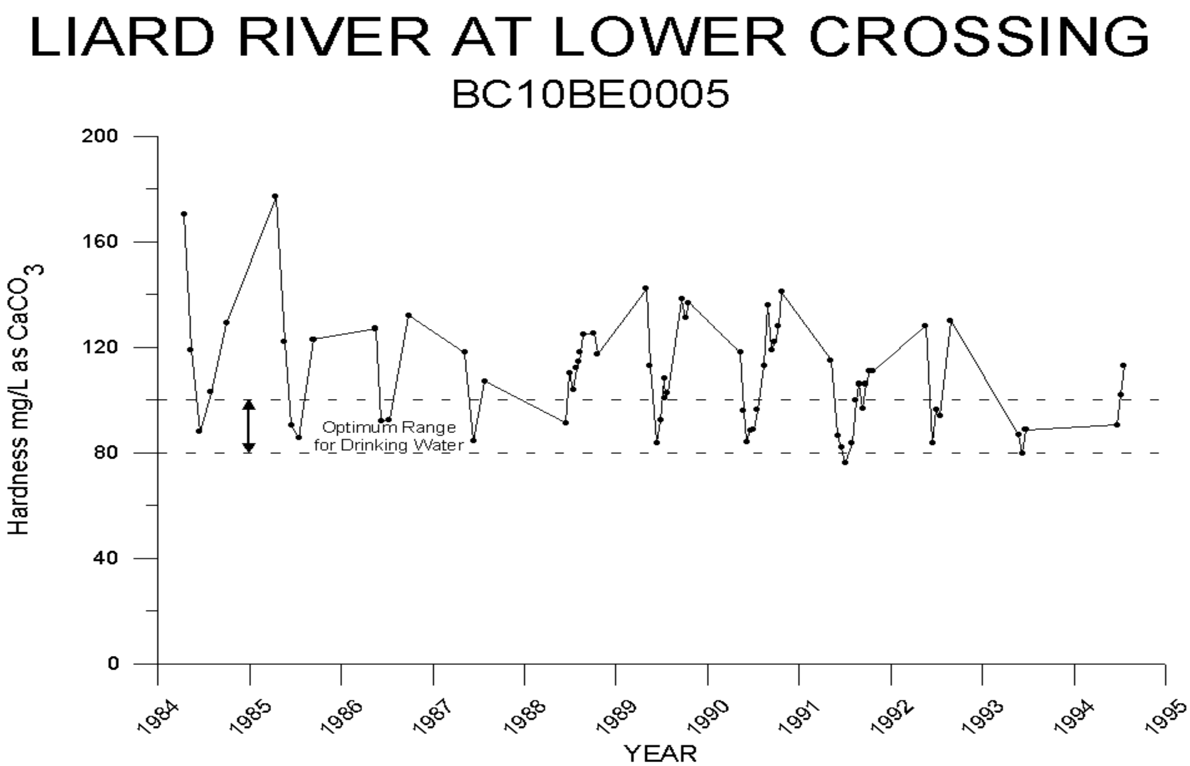


Figure 17 Total Iron

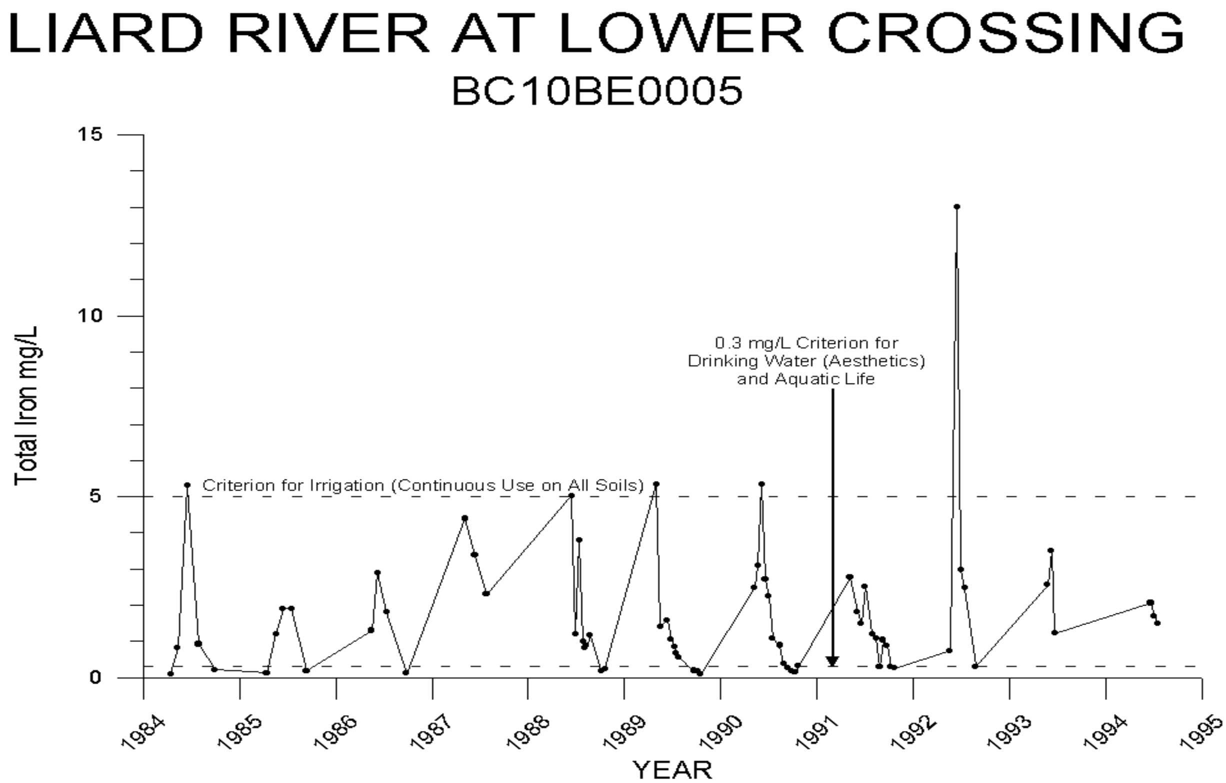


Figure 18 Total Lead

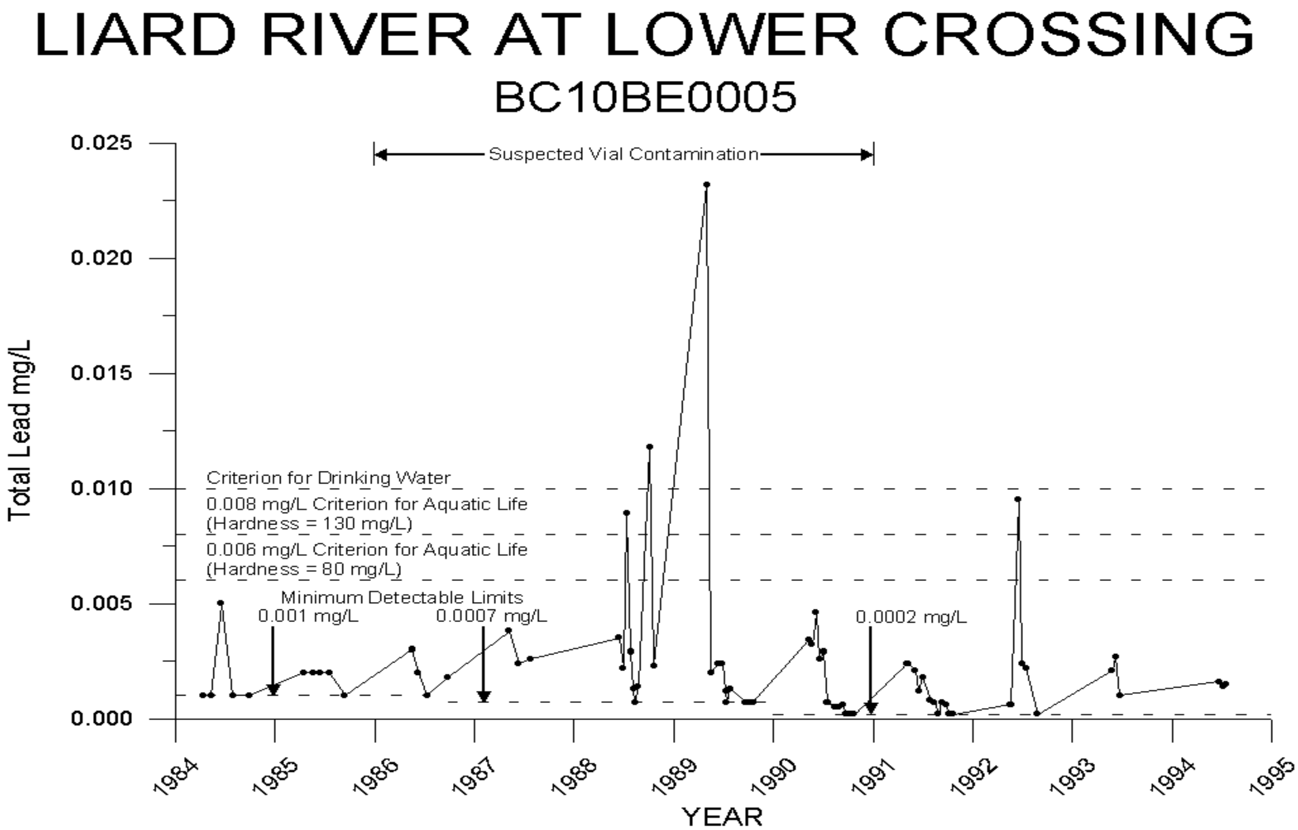


Figure 19 Total Lithium

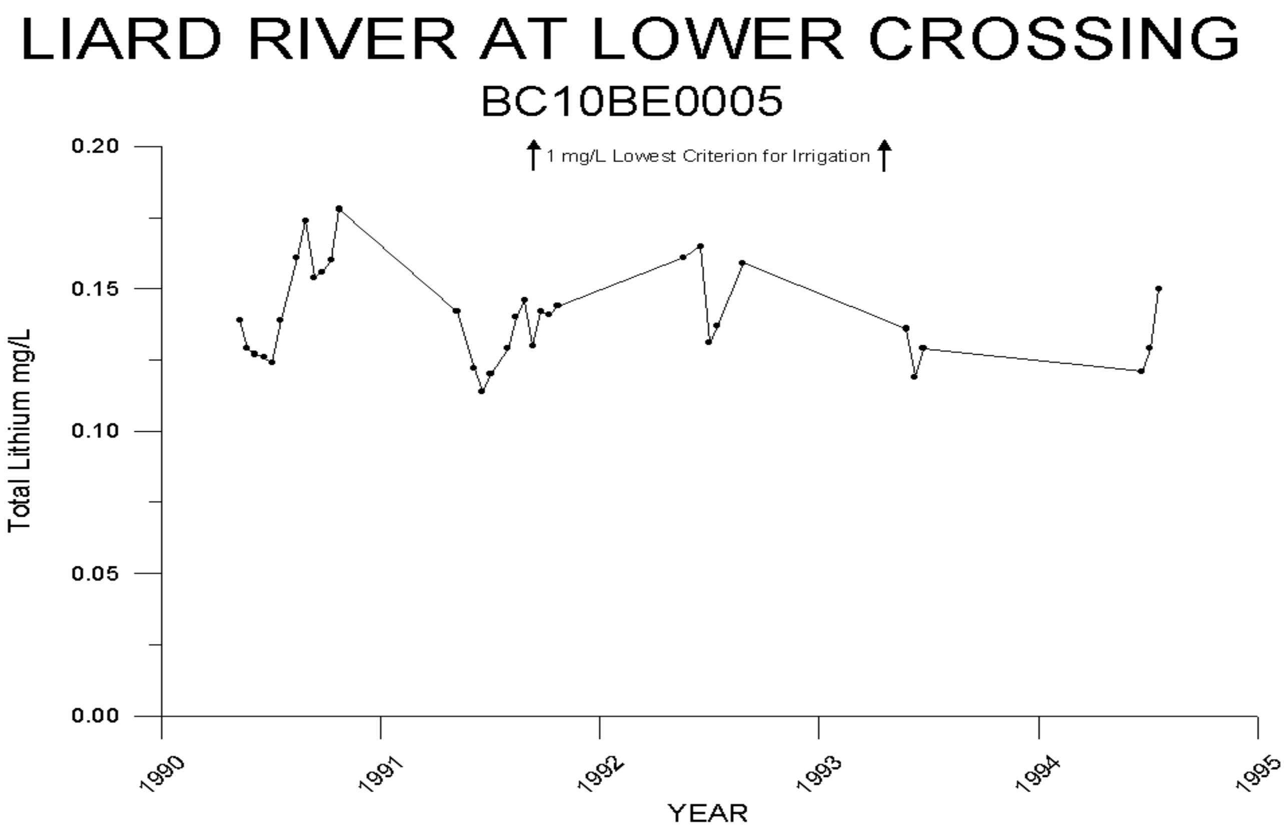


Figure 20 Magnesium

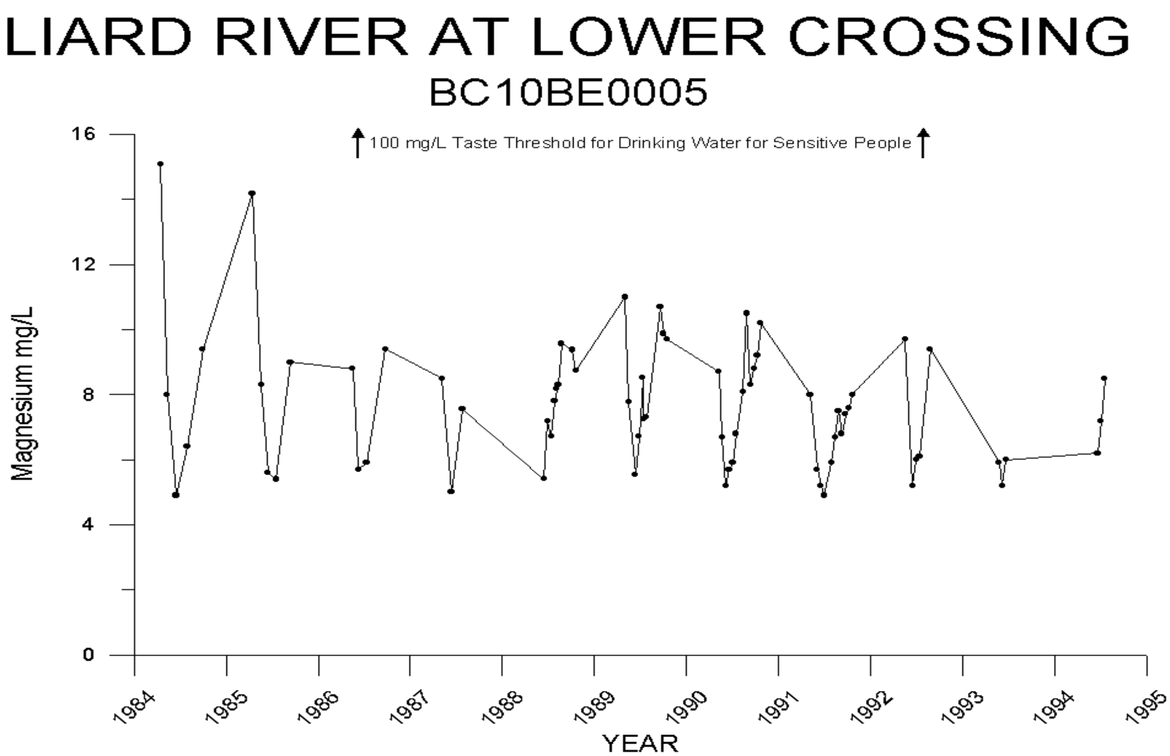


Figure 21 Total Manganese

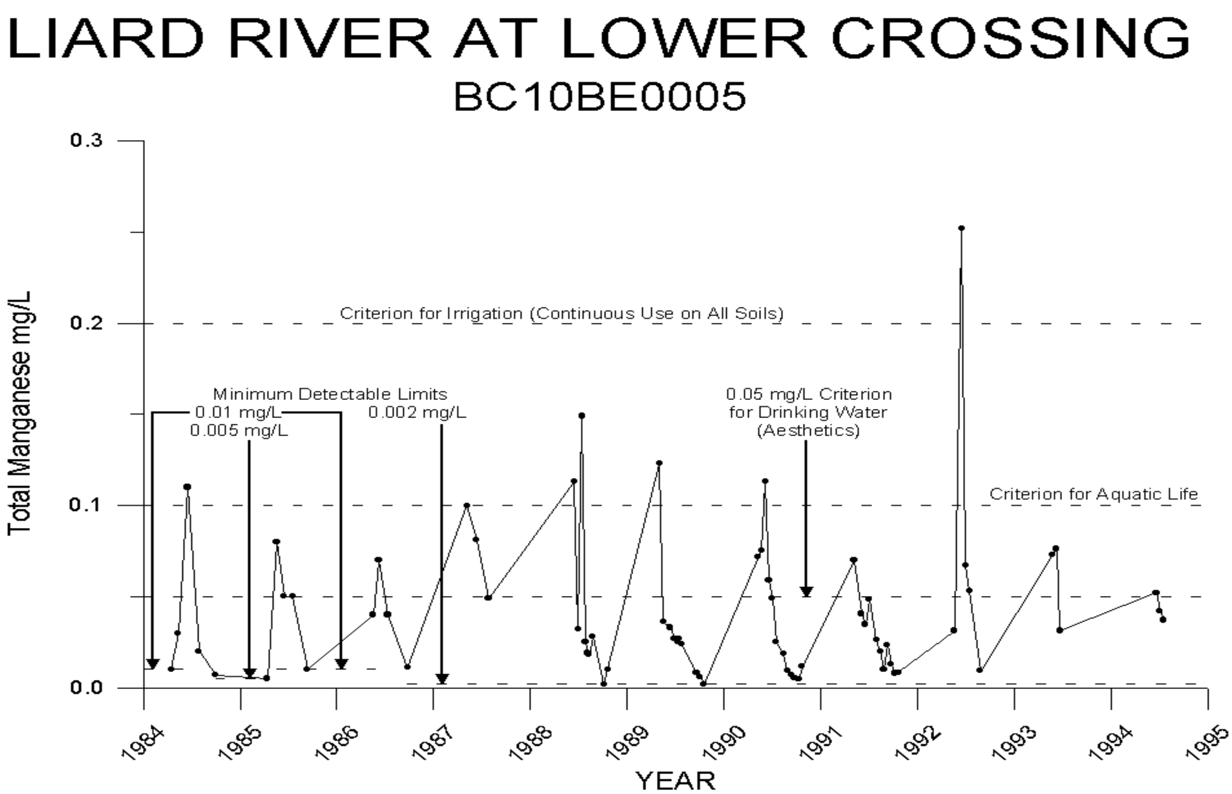


Figure 22 Total Molybdenum

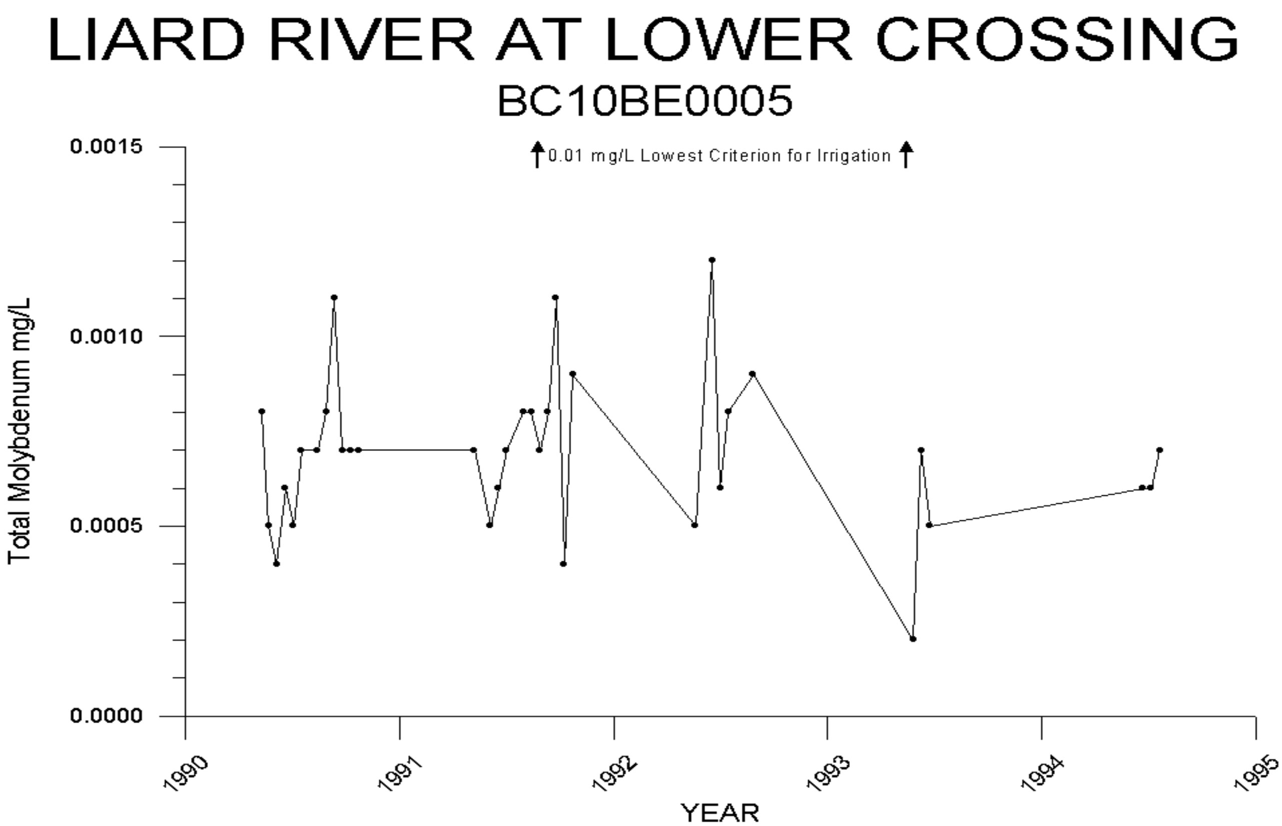


Figure 23 Total Nickel

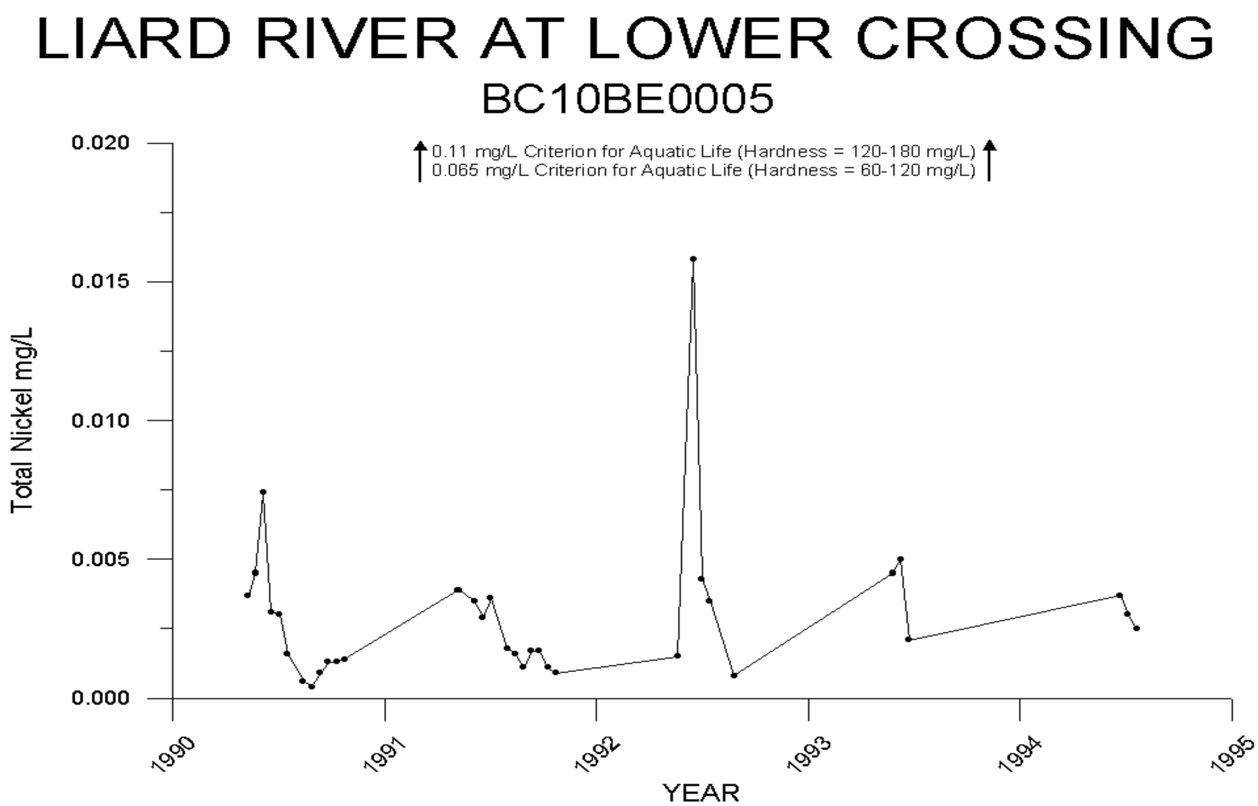


Figure 24 Nitrogen (Nitrate/Nitrite)

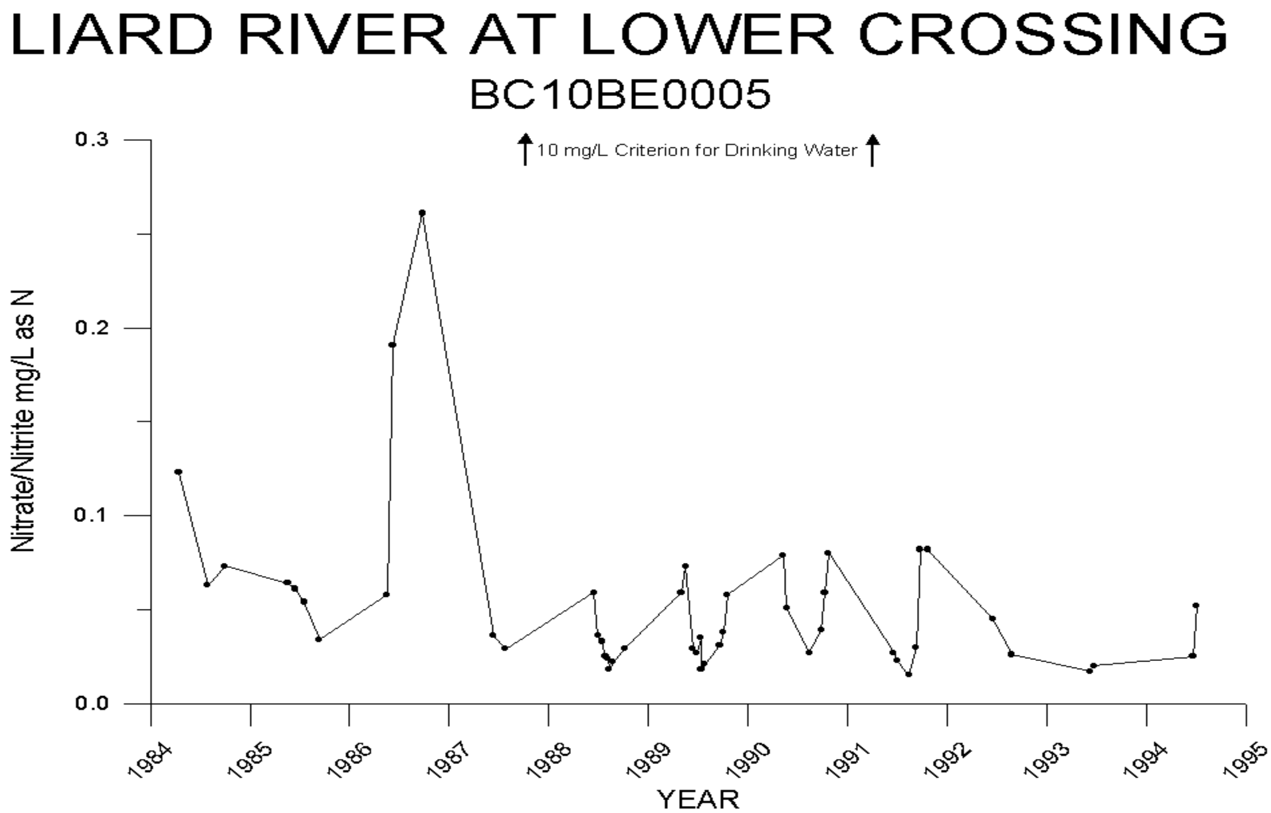


Figure 25 Total Dissolved Nitrogen

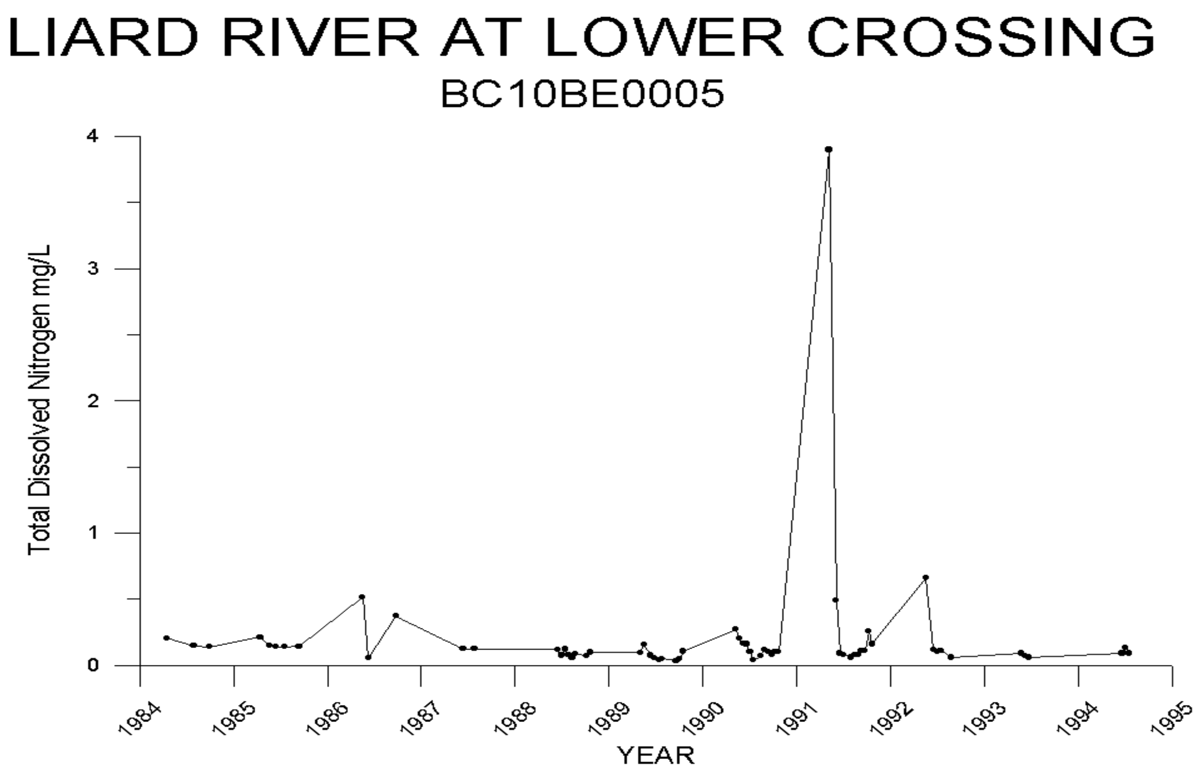
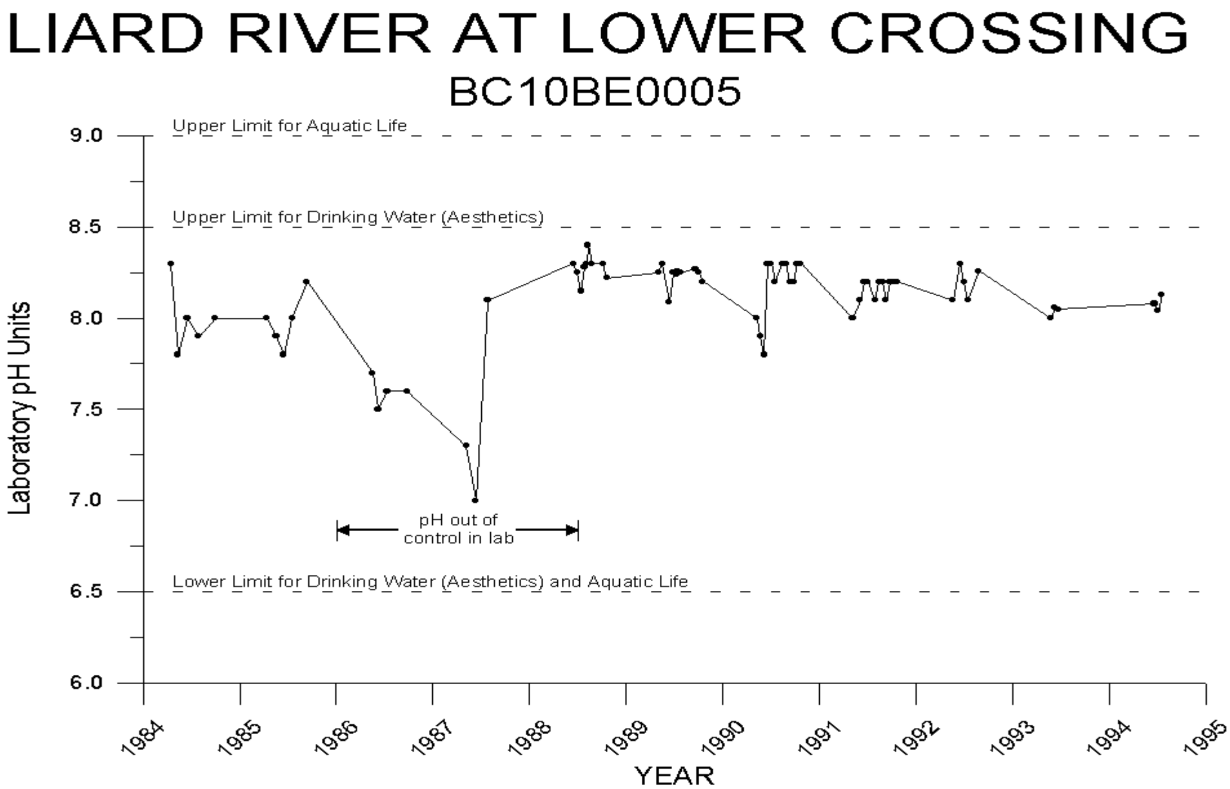


Figure 26 pH



LIARD RIVER AT LOWER CROSSING
BC10BE0005
Upper Limit for Aquatic Life
Upper Limit for Drinking Water (Aesthetics)
pH out of
control in lab
Lower Limit for Drinking Water (Aesthetics) and Aquatic Life
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Laboratory pH Units
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
YEAR

Figure 27 Total Phosphorus

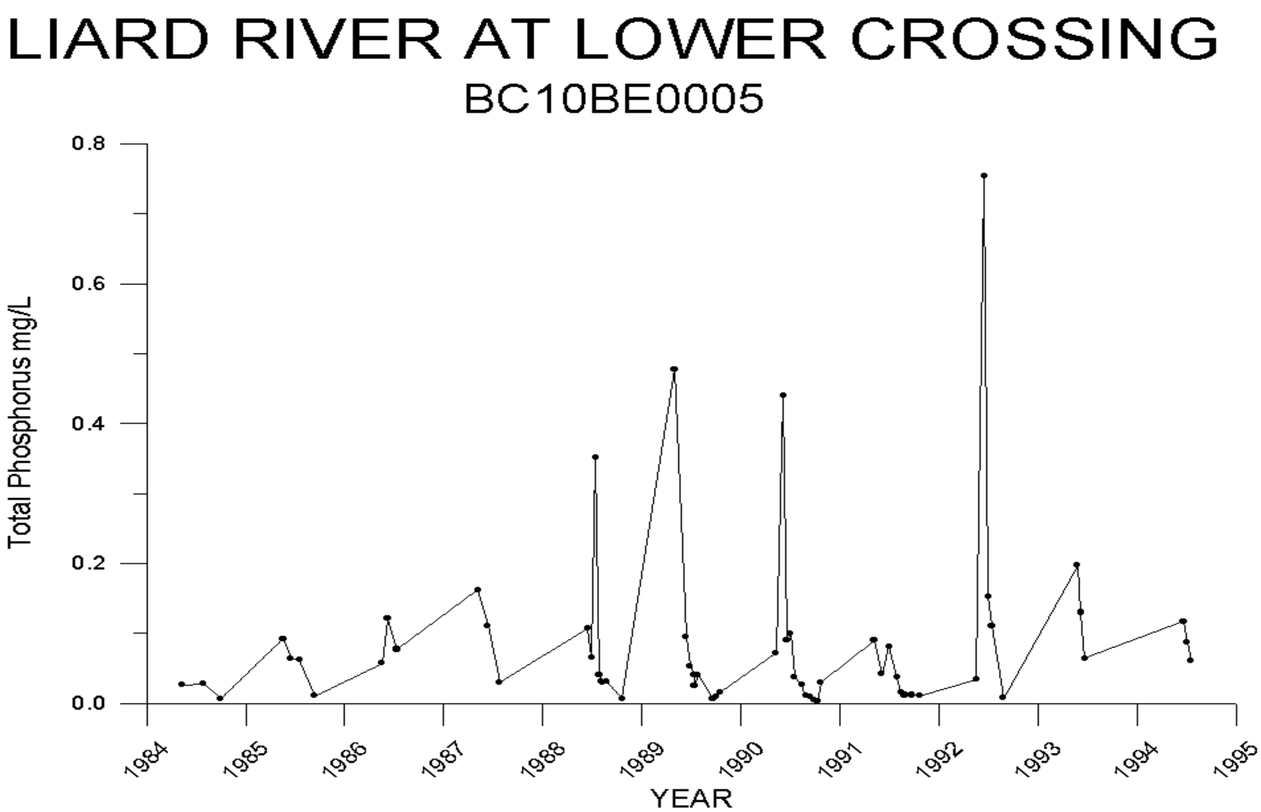


Figure 28 Potassium

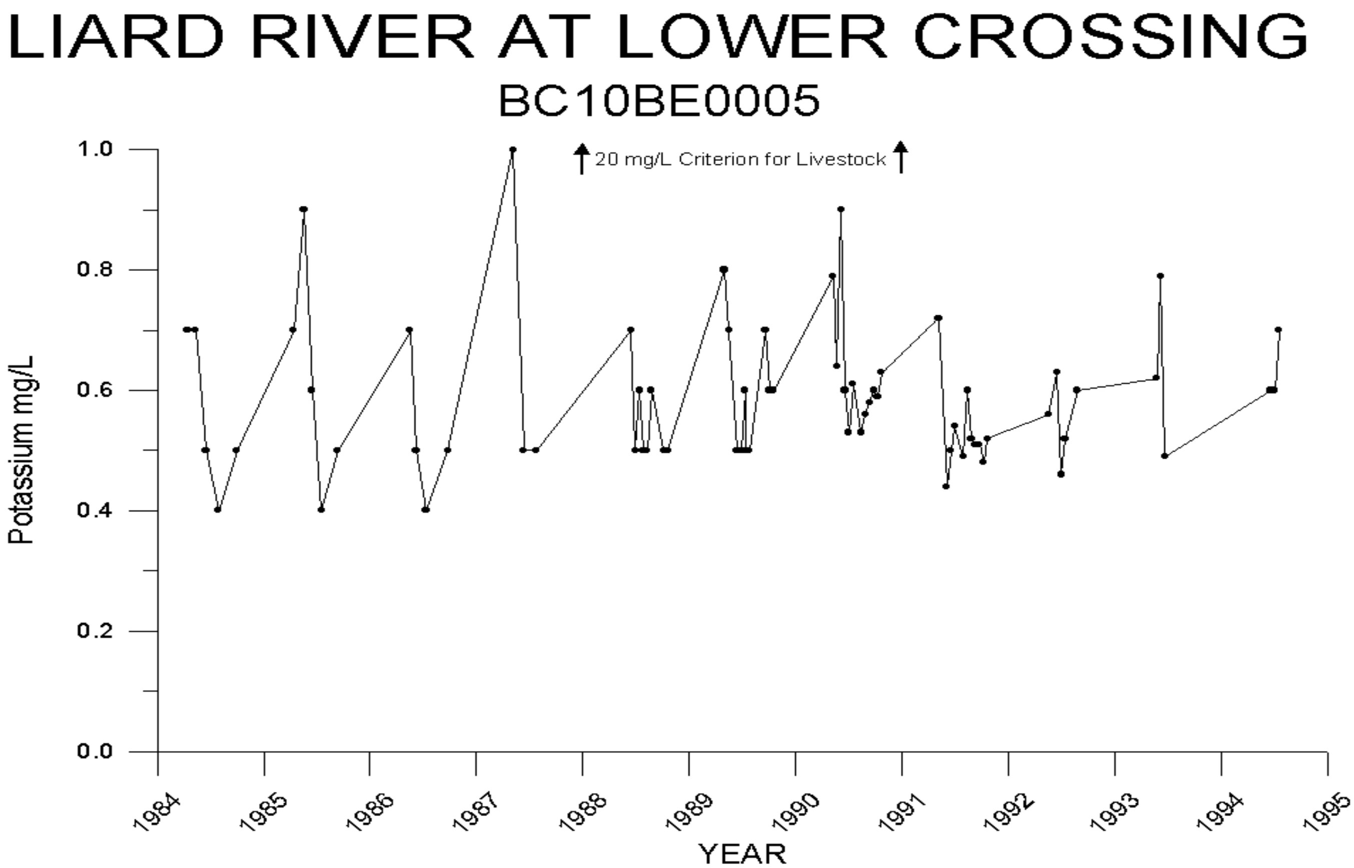


Figure 29 Filterable Residue

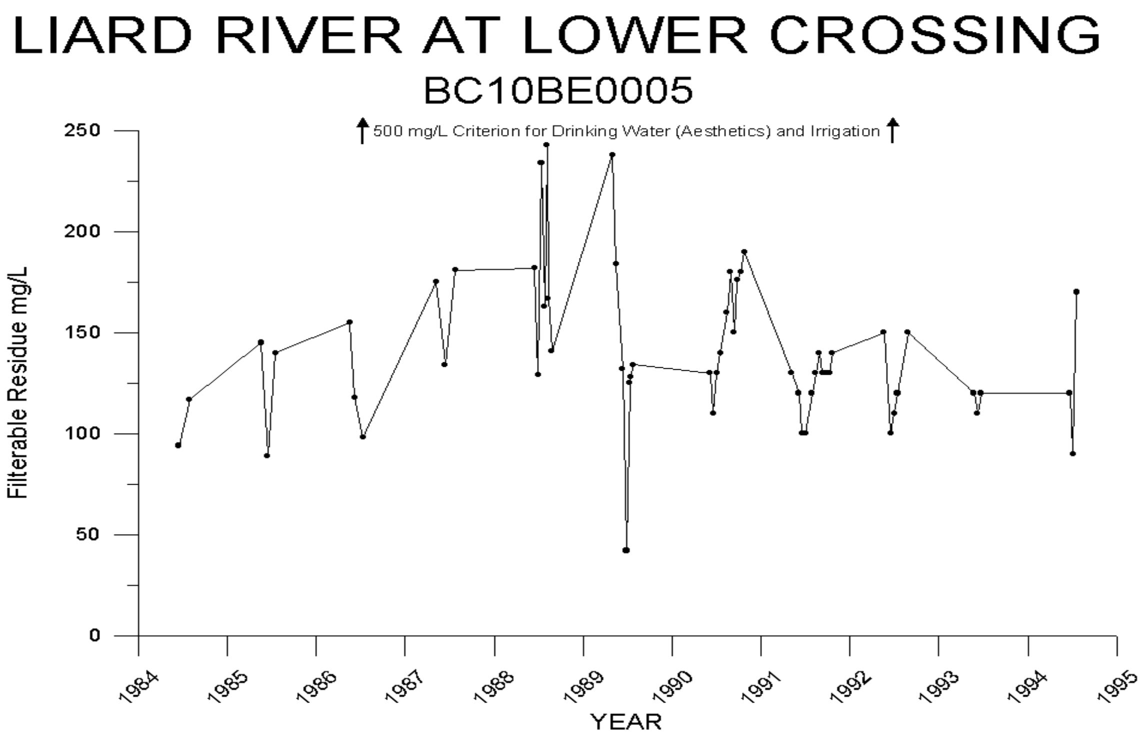


Figure 30 Non-Filterable Residue

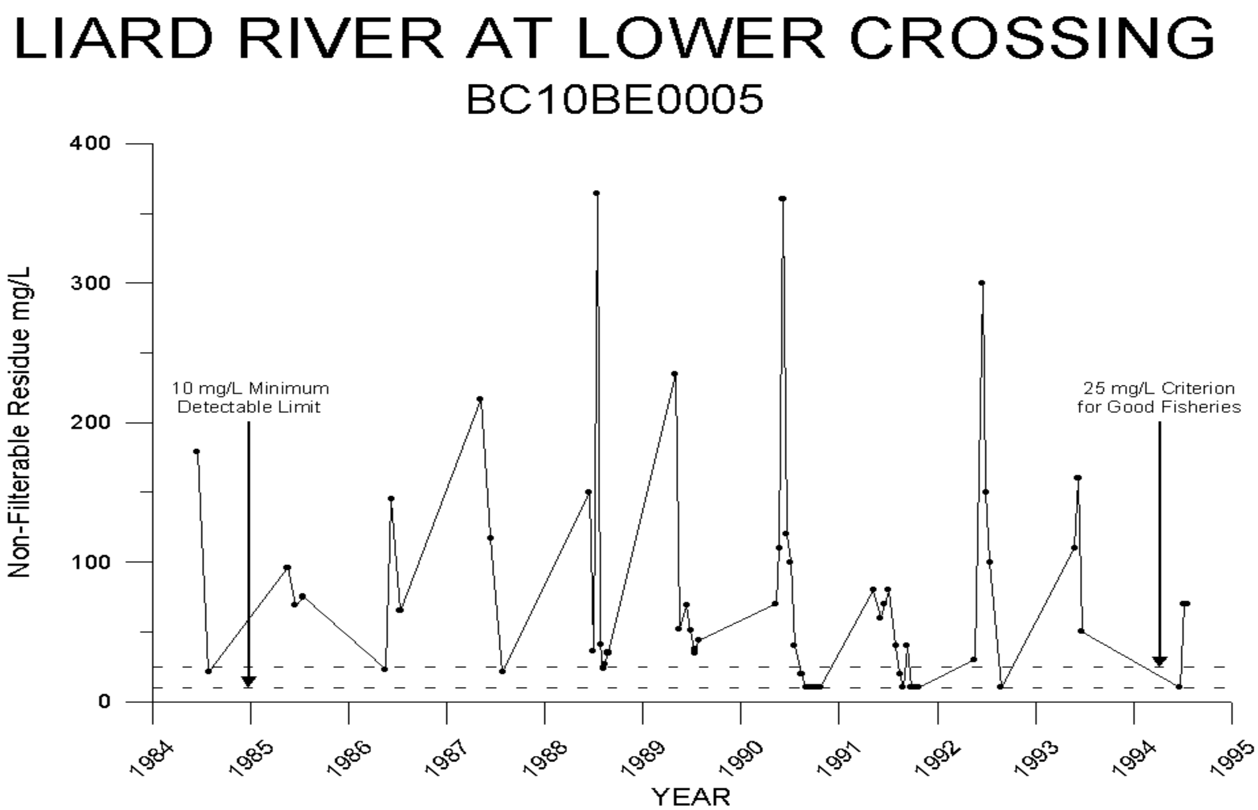


Figure 31 Fixed Filterable Residue

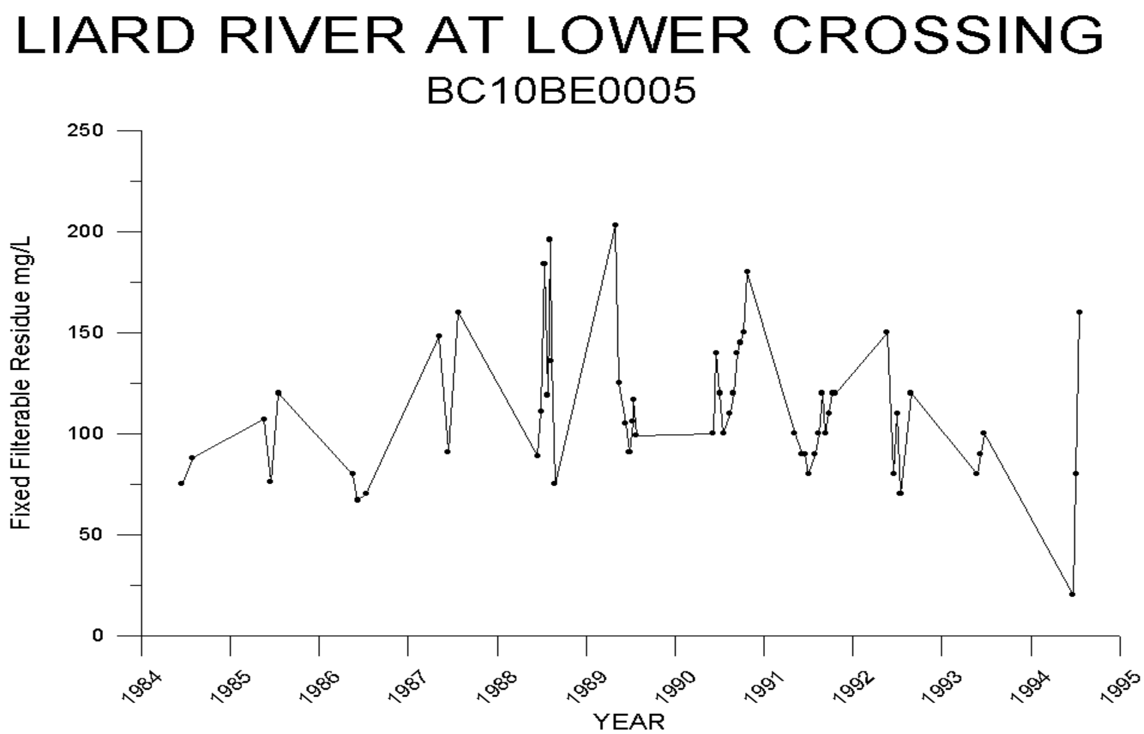


Figure 33 Total Selenium

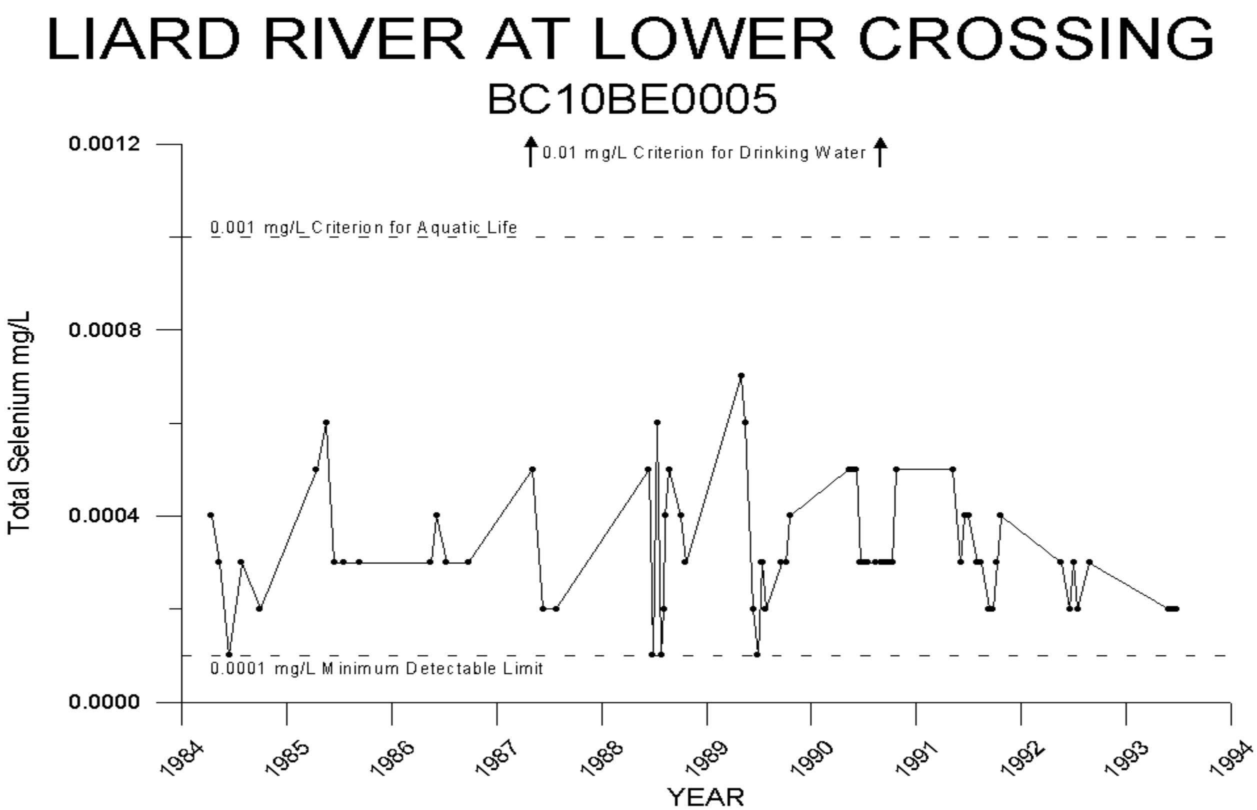


Figure 34 Silica

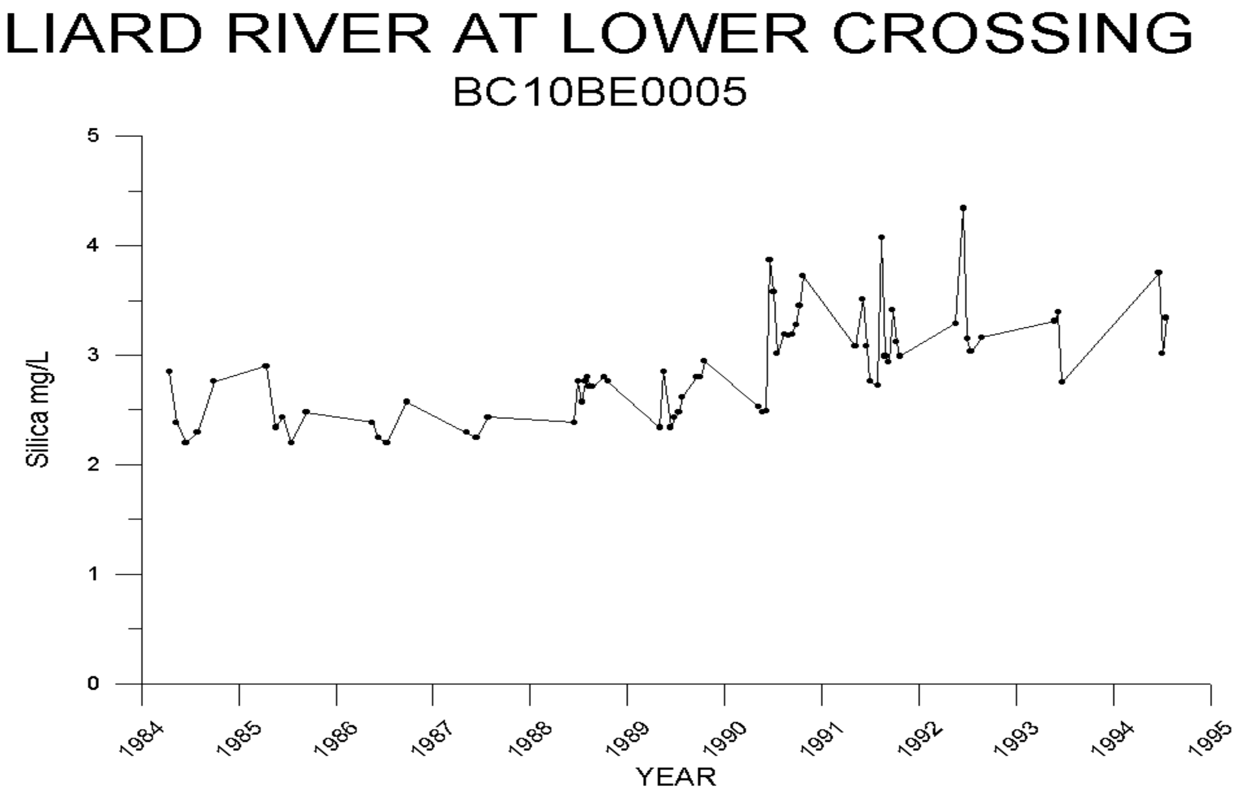


Figure 35 Sodium

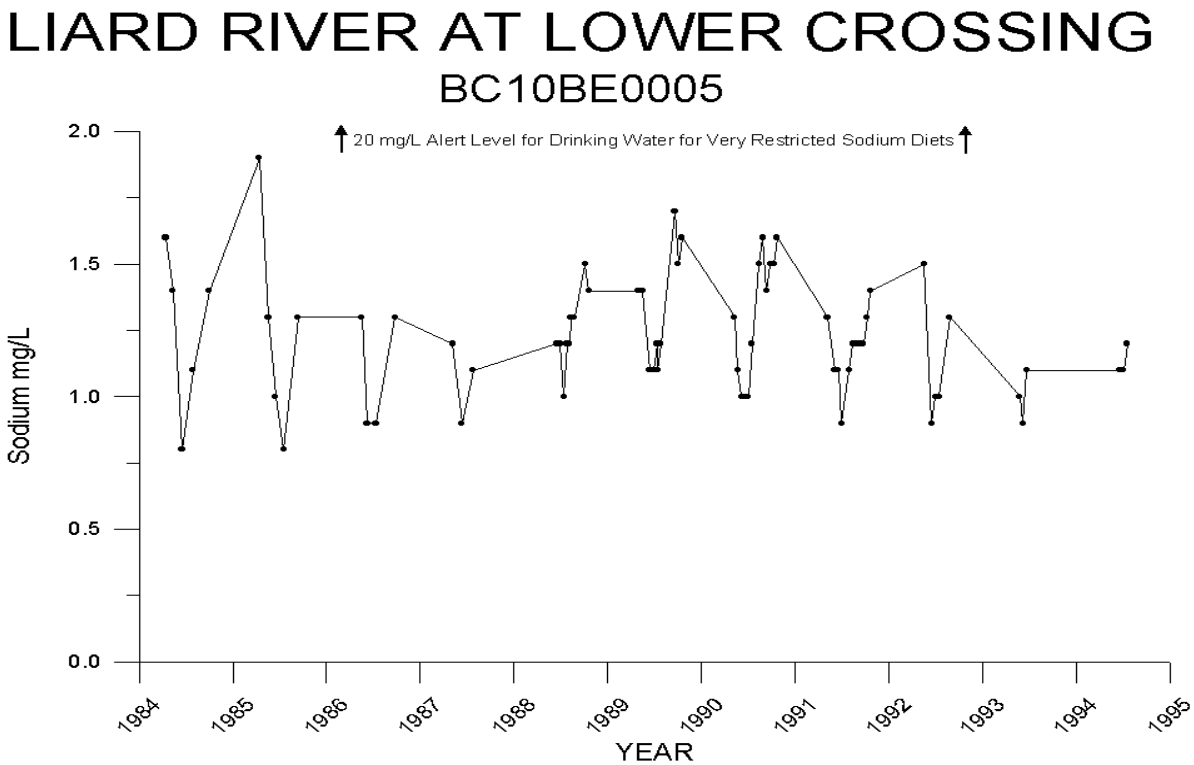


Figure 36 Specific Conductivity

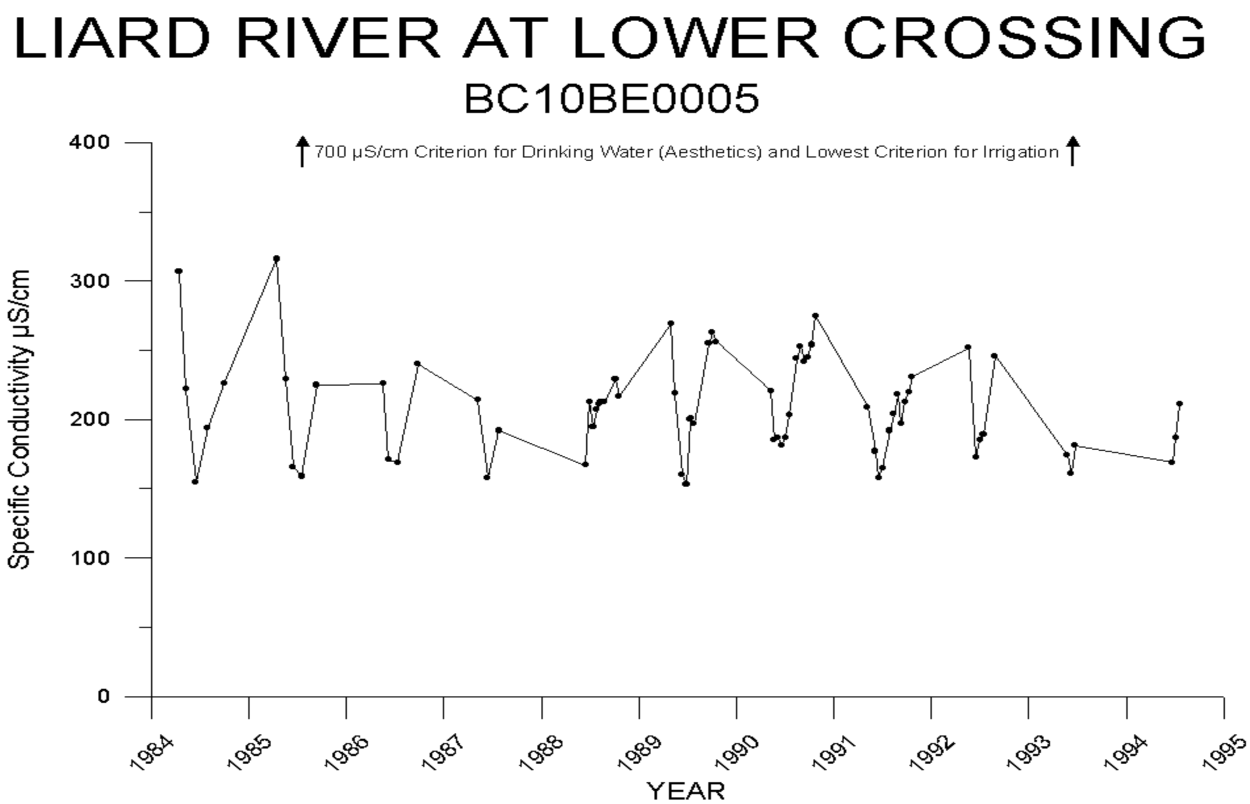


Figure 37 Total Strontium

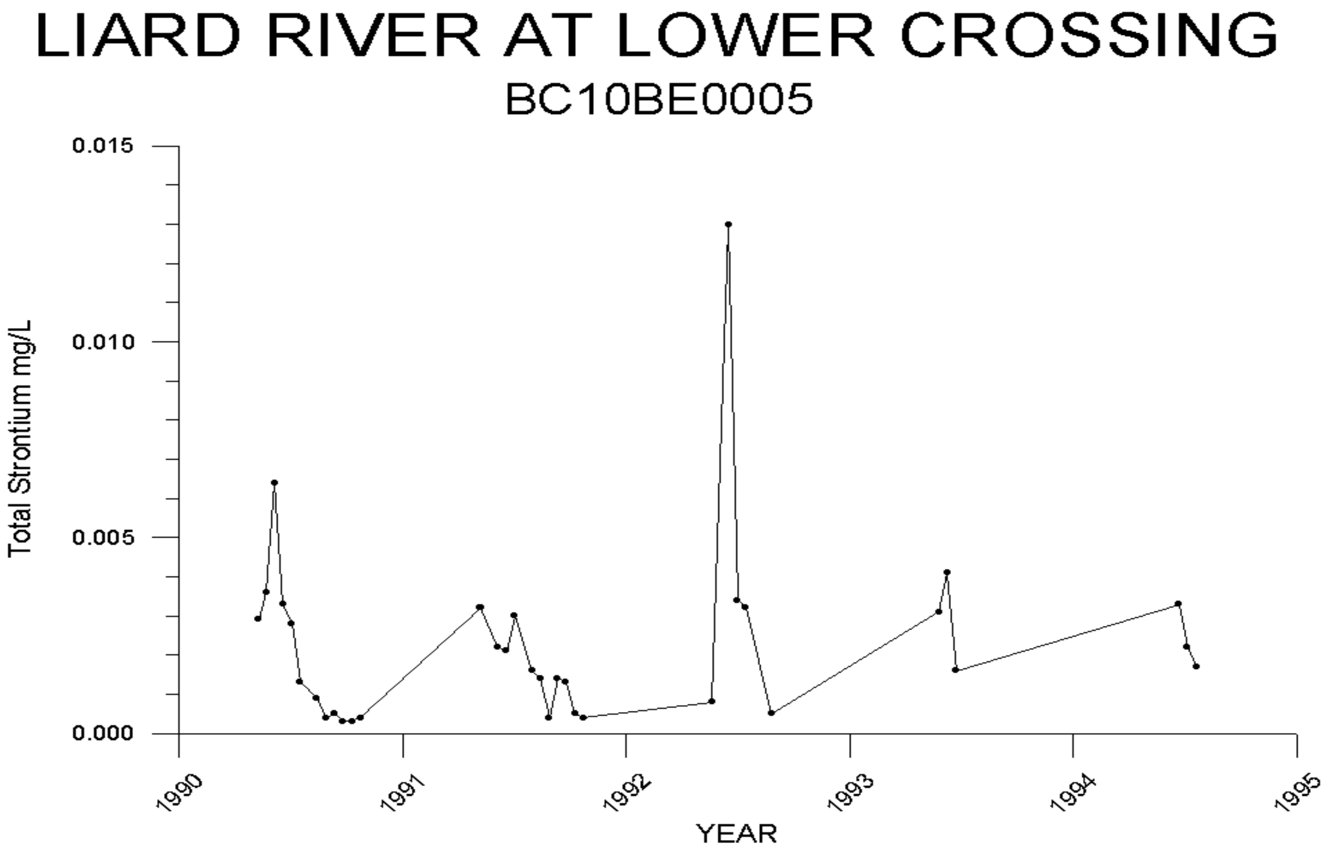


Figure 38 Dissolved Sulphate

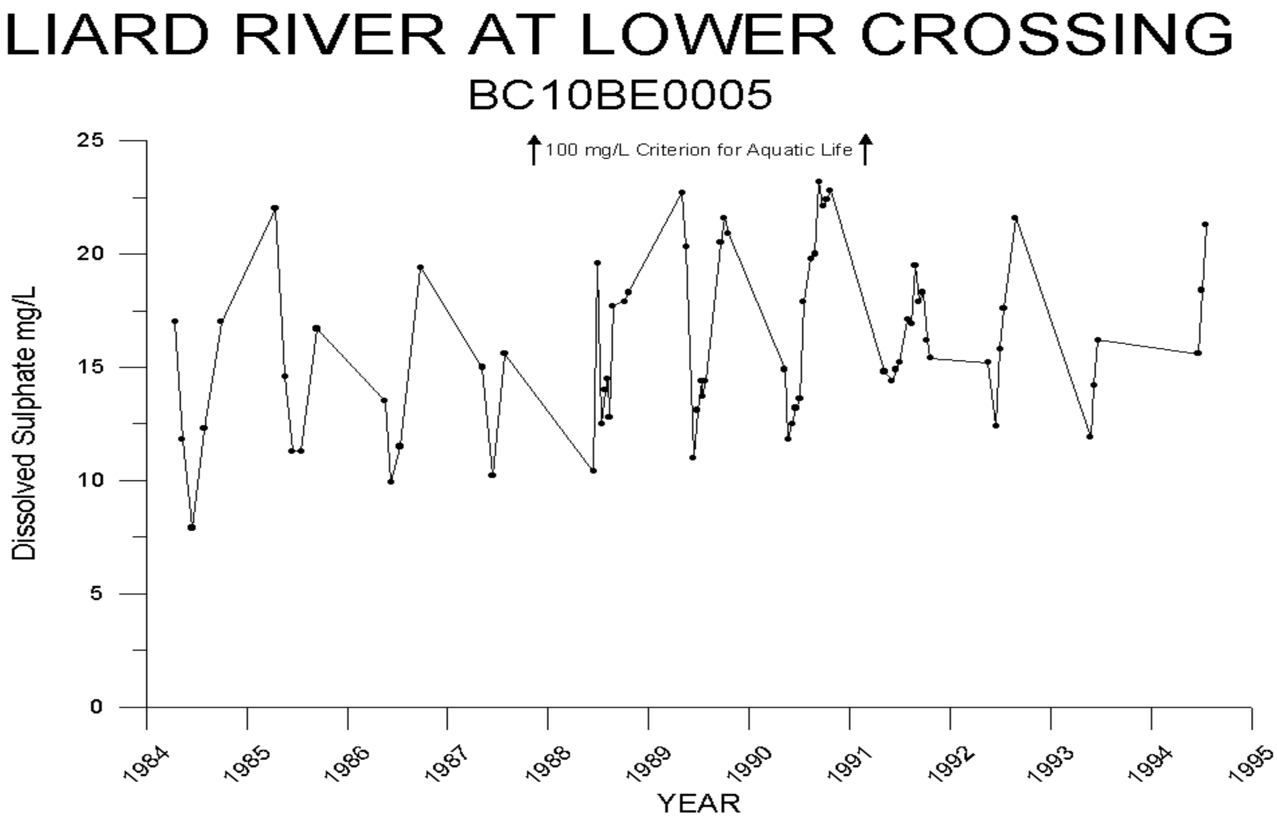


Figure 39 Air Temperature

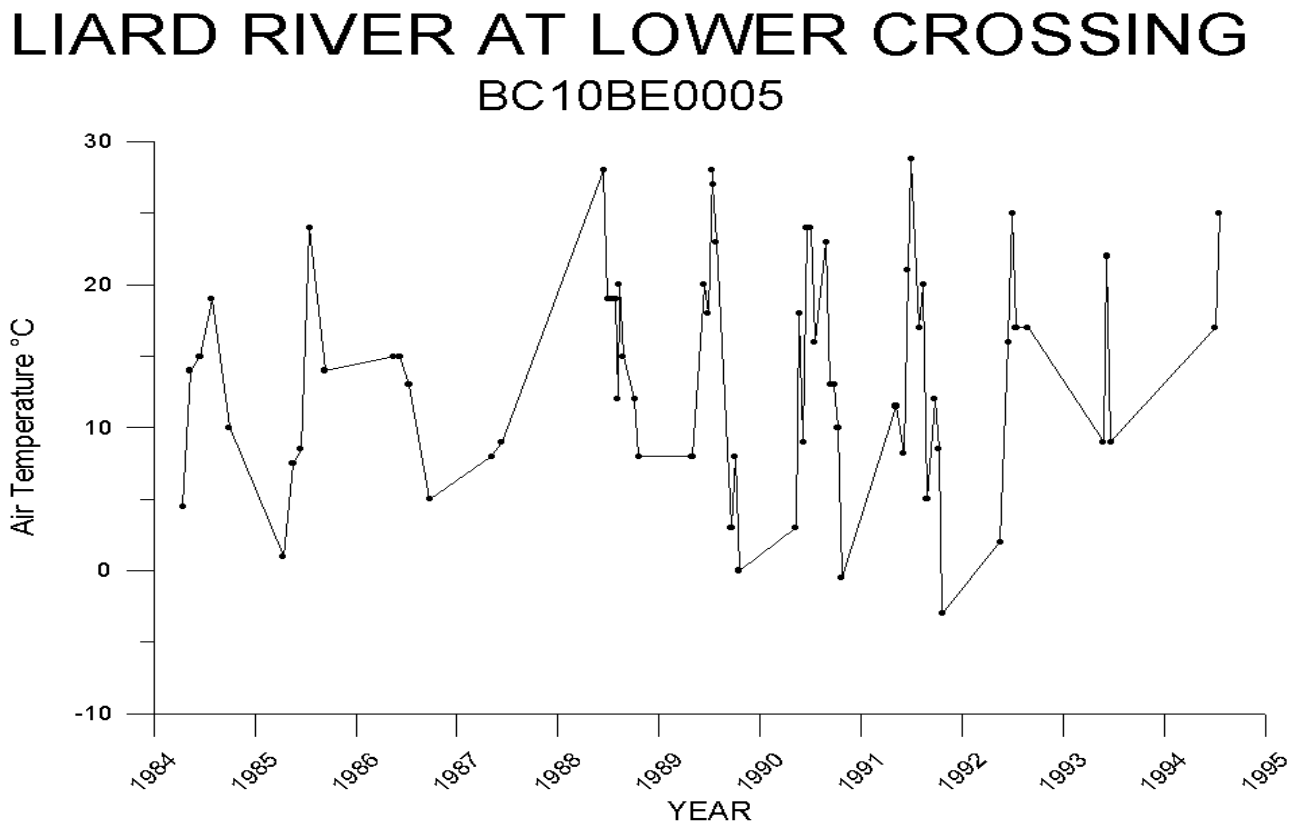


Figure 40 Water Temperature

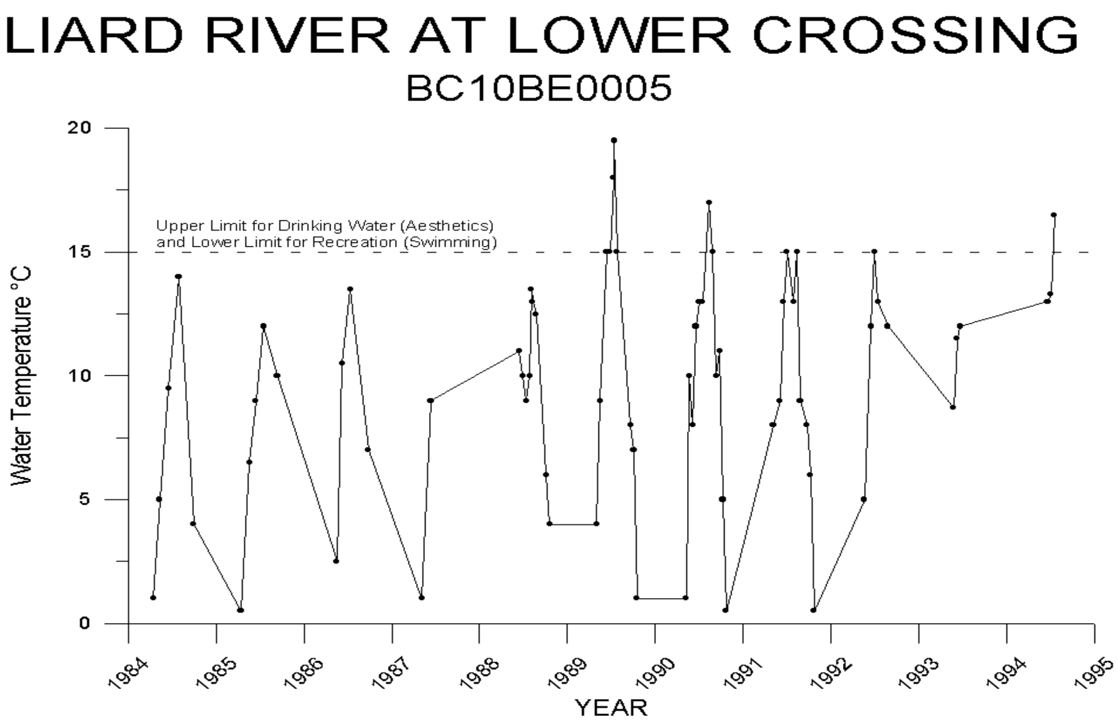


Figure 41 Turbidity

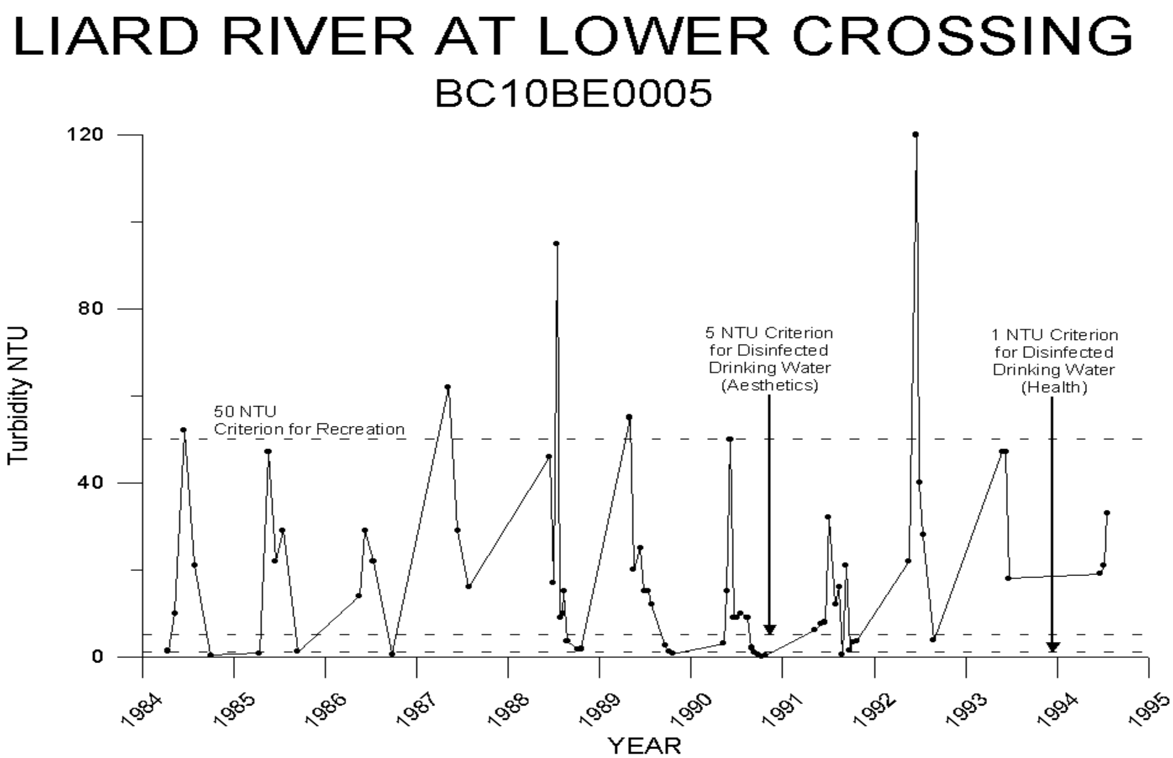
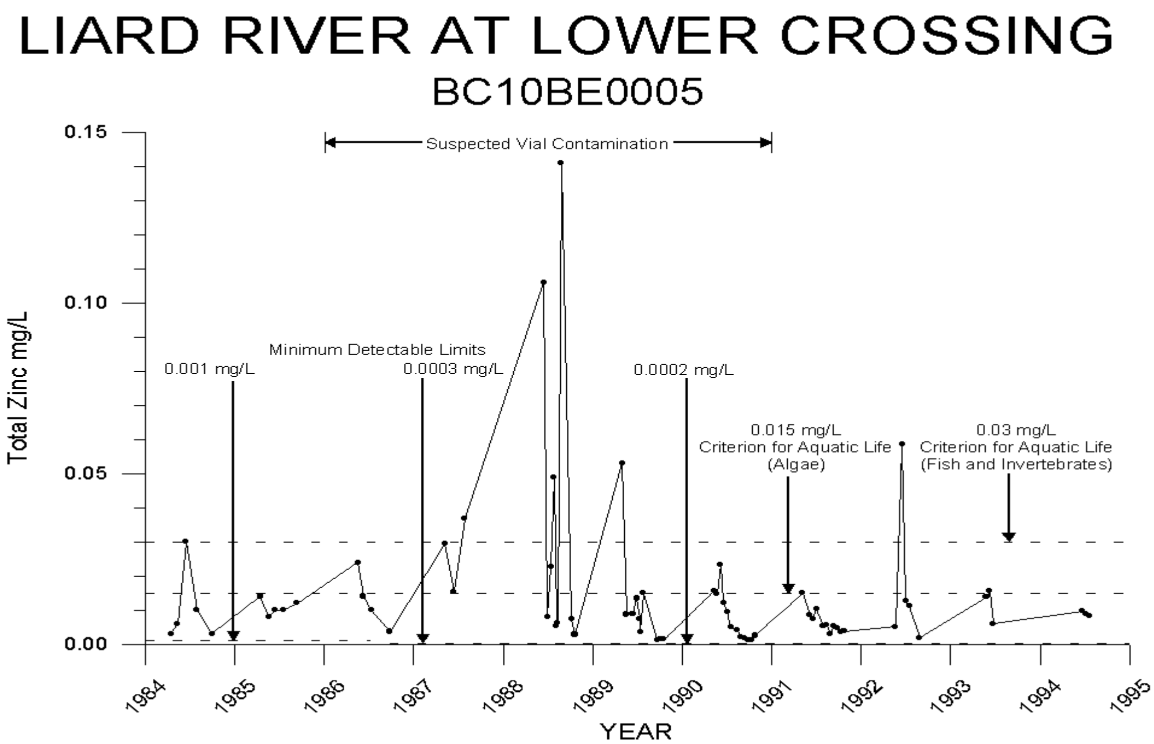


Figure 42 Total Zinc



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