



## State of Water Quality of Liard River at Fort Liard 1984-1995

### 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

November, 1996

### Canadian Cataloguing in Publication Data

Main entry under title:

Jang, L. (Leon), 1975- State of water quality of Liard River at Fort Liard, 1984-1995.

At head of title: Canada-British Columbia Water Quality Monitoring Agreement.

Authors: Jang, L., Pommen, L.W. Cf. P.

Co-published by British Columbia, Ministry of Environment, Lands and Parks.

Includes bibliographical references: p.

ISBN 0-7726-3079-8

1. Water quality - Liard River. 2. Water quality - Northwest Territories - Fort Liard. 3. Water - Pollution - Liard River. 4. Water - Pollution - Northwest Territories - Fort Liard. I. Pommen, L. W. (Larry Wayne), 1948- . II. Canada. Environment Canada. III. British Columbia. Ministry of Environment, Lands and Parks. IV. Canada-British Columbia Water Quality Monitoring Agreement. V. Title.

TD227.L5J36 1996 363.73'942'097193 C96-960367-3

### 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 various activities including oil and gas development, mining, forestry and agriculture.

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 Fort Liard monitoring station, located at the Hudson's Bay

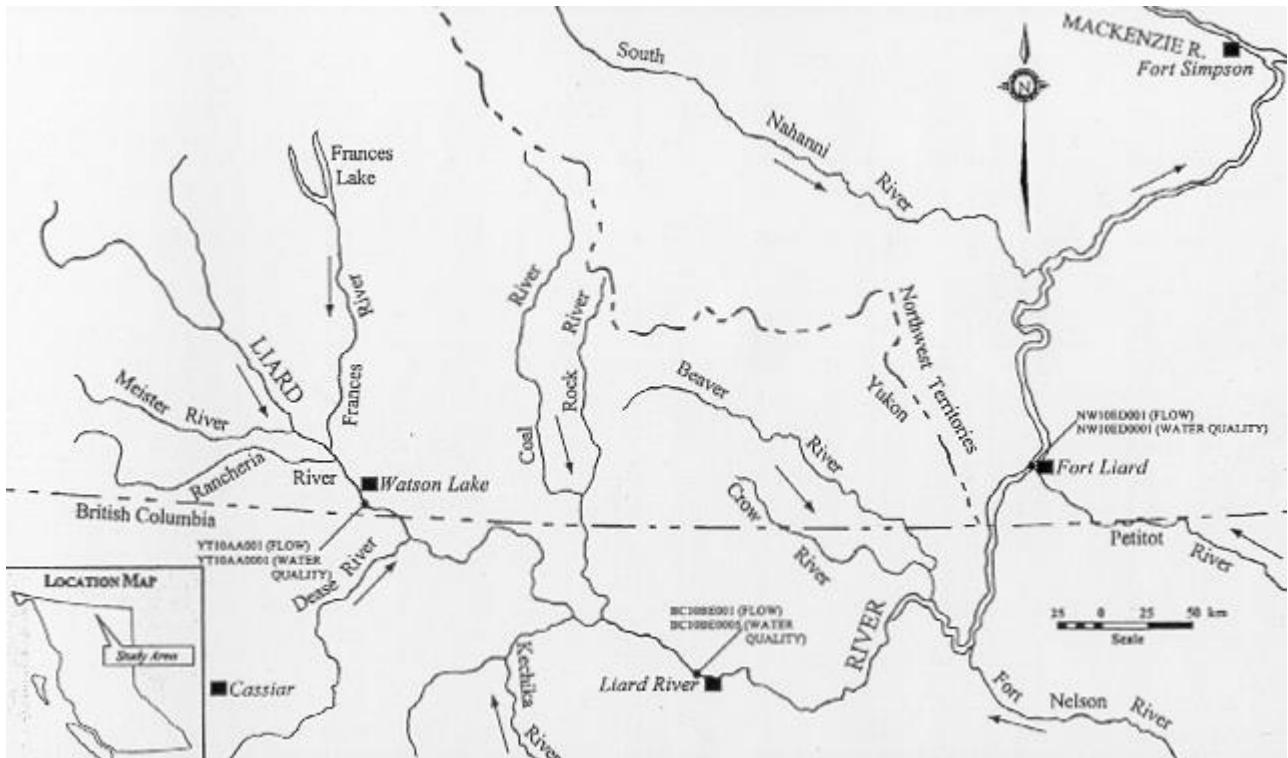
Company Post near Fort Liard. Water quality samples were collected between 1984 and 1995 by Environment Canada. Flow was measured at a Water Survey of Canada flow gauge at the water quality monitoring station.

We concluded that:

- There were no environmentally significant trends in water quality that could be identified through visual examination of the data.
- Total aluminum, arsenic, cadmium, organic carbon, chromium, copper, iron, lead, manganese, selenium, 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 substances were probably not biologically available and would be removed by drinking water treatment needed to remove turbidity.
- Turbidity removal and disinfection are needed prior to drinking.
- The river was often too turbid for recreation during the summer.
- The river had a low sensitivity to acid inputs.
- Hardness levels were mostly above the optimum range for drinking water, reaching the poor range during winter.
- The water was cool enough for drinking except during the summer, when it was warm enough for water-contact recreation.

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

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



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## **Introduction**

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The Liard River originates in the southern portion of the Yukon Territory. 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 Fort Nelson River comes from the south and meets the Liard 50 km before the Northwest Territories border. The Petitot River from the east joins the Liard River at Fort Liard. Other major tributaries which are further upstream include the Frances River from the north and the Kechika River 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). The Fort Liard monitoring station is located at the Hudson's Bay Company Post, 1.2 km downstream from the confluence with the Petitot River. The water quality of the other two stations is discussed in two separate reports (Jang & Pommen, 1996a & 1996b).

Upstream from Fort Liard, oil and gas developments are located mainly on the Fort Nelson and Petitot Rivers and their tributaries. Mining activities on the Liard are concentrated upstream near the Dease and Kechika Rivers and downstream on the South Nahanni River. Forestry in the Liard River basin occurs in the Yukon and British Columbia. Some agricultural activities are present near Fort Nelson. 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 1995, and are stored under ENVIRODAT station number NW10ED0001. The water quality indicators are plotted in Figures 3-45. Water Survey of Canada operates a flow gauge at the water quality monitoring station (site number NW10ED001). The drainage area at the flow station is 222 000 km<sup>2</sup>. Flow data are graphed in Figure 2.

## **Quality Assurance**

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The water quality graphs were inspected and erroneous values were removed. There were questionable values for aluminum, nitrogen, phosphorus, apparent colour, pH, non-filterable residue and fixed non-filterable residue. 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 (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**

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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 environmentally significant trends. These include: barium, beryllium, total inorganic carbon, 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, silica, sodium, specific conductivity, strontium, sulphate, air temperature, and vanadium.

**Flow** (Figure 2) values were highest during spring freshet (May-July). Peak flow values were similar in most years except for higher values in 1988 and 1990. The lowest peak values occurred in 1989 and 1993.

**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 10% of the time. Peak aluminum values corresponded to peak non-filterable residues 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 arsenic** (Figure 5) exceeded the 0.005 mg/L proposed criterion for aquatic life 8% of the time. These values occurred at the same time as high non-filterable residues and turbidity. This indicates that the arsenic was in a particulate form and probably not biologically available.

**Total cadmium** (Figure 8) values between 1986 and 1991 were questionable due to suspected preservative vial contamination. Minimum detectable limits (0.0001 mg/L & 0.001 mg/L) were 2 to 33 times above the aquatic life criteria (0.00003 mg/L to 0.00006 mg/L). Peak cadmium values corresponded to peak periods of non-filterable residues and turbidity. This indicates that the cadmium was in a particulate form and 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 organic carbon** (Figure 11) exceeded the 4 mg/L drinking water criterion 44% of the time. Most of the higher values corresponded to elevated non-filterable residue and turbidity, suggesting that the carbon was in a particulate form and would be removed by the turbidity removal needed before drinking.

**Total chromium** (Figure 13) values in 1990 were high due to preservative vial contamination. Since then, one value (June 27, 1995) exceeded the 0.02 mg/L aquatic life criterion for fish, and 40% of the values exceeded the 0.002 mg/L aquatic life criterion for phyto- and zoo-plankton. High chromium values corresponded to high non-filterable residues and turbidity. This indicates that the chromium was in a particulate form and probably not biologically available.

**Apparent colour** (Figure 15) met the 100-unit recreation (maximum) criterion at least 89% of the time. Also, the 15-unit drinking water and recreation criterion was met 45% of the time. All criteria are given as true colour values, where turbidity is removed before measurement. Most of the 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 16) values were high between 1986 and 1991 due to preservative vial contamination. Outside this period, 14% of the values exceeded the upper (0.009 mg/L) aquatic life criterion, and 51% of the values exceeded the lower (0.002 mg/L) aquatic life criterion. High copper and non-filterable residues and turbidity occurred together during peak flows. This indicates that the copper was in a particulate form and probably not biologically available.

**Hardness** (Figure 18) values were above the optimum range for drinking water (80-100 mg/L as CaCO<sub>3</sub>) 94% of the time, and reached the poor, but still tolerable, level (200 mg/L) during the winter.

**Total iron** (Figure 19) exceeded the 5 mg/L irrigation criterion 18% of the time, while the 0.3 mg/L drinking water and aquatic life criterion was exceeded 69% of the time. High values of iron corresponded with high non-filterable residues and turbidity. This indicates that the iron was in a particulate form and probably not biologically available and would be removed by the turbidity removal needed before drinking.

**Total lead** (Figure 20) values between 1986 and 1991 were questionable due to suspected preservative vial contamination. Outside this period, the 0.01 mg/L drinking water criterion was exceeded twice (June 17, 1991 and June 29, 1993). Also, the 0.005 mg/L aquatic life lower criterion was exceeded by 16% of the values. High lead and non-filterable residues and turbidity occurred together during high flow. 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 manganese** (Figure 23) exceeded the 0.2 mg/L criterion for irrigation 7% of the time. Also, the 0.1 mg/L criterion for aquatic life was exceeded 17% of the time, and the 0.05 mg/L criterion for drinking water was exceeded 37% of the time. High manganese and non-filterable residues and turbidity occurred together during periods of high flow. 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 32) exceeded the 25 mg/L criterion for good fisheries 64% of the time, particularly during high flows. The patterns of non-filterable residue and turbidity (Figure 43) were very similar.

**Total selenium** (Figure 35) values exceeded the 0.001 mg/L criterion for aquatic life 8% of the time. Most of these values (7 of 10) occurred when non-filterable residue and turbidity were high, suggesting that the selenium may have been in a particulate form and not bio-available. However, the other three values occurred when non-filterable residue was low to moderate (0 to 100 mg/L). Dissolved and total selenium should be measured in the future.

**Water temperature** (Figure 42) exceeded the 15°C aesthetic limit for drinking water and the lower limit for recreation 19% of the time, with all peak temperatures occurring between June and August. This means that the water was cool enough to be aesthetically pleasing for drinking, except during the summer, when it was warm enough for water-contact recreation such as swimming. However, the water temperatures warm enough for swimming often occurred when turbidity exceeded the criterion for recreation.

**Turbidity** (Figure 43) values exceeded the 50 NTU criterion for recreation 22% of the time, mainly during freshet. The 5 NTU aesthetic criterion for drinking water was exceeded 61% of the time, and the 1 NTU health criterion for drinking water was exceeded 78% of the time. Turbidity removal and disinfection are needed prior to drinking.

**Total zinc** (Figure 45) exhibited high values between 1986 and 1991, which may have been due to suspected preservative vial contamination. Outside this period, 18% of the values exceeded the 0.03 mg/L fish and invertebrates criterion, and 31% exceeded the 0.015 mg/L algae criterion. Peak zinc values corresponded to peak non-filterable residue and turbidity. This indicates that the zinc was in a particulate form and probably not biologically available.

### **Conclusions - State of Water Quality**

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- There were no environmentally significant trends in water quality that could be identified through visual examination of the data.
- Total aluminum, arsenic, cadmium, organic carbon, chromium, copper, iron, lead, manganese, selenium, 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 substances were probably not biologically available and would be removed by drinking water treatment needed to remove turbidity.
- Turbidity removal and disinfection are needed prior to drinking.
- The river was often too turbid for recreation during the summer.
- The river had a low sensitivity to acid inputs.
- Hardness levels were mostly above the optimum range for drinking water, reaching the poor range during winter.
- The water was cool enough for drinking except during the summer, when it was warm enough for water-contact recreation.

### **Recommendations for Water Quality Management**

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#### **Remediation**

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

#### **Monitoring**

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

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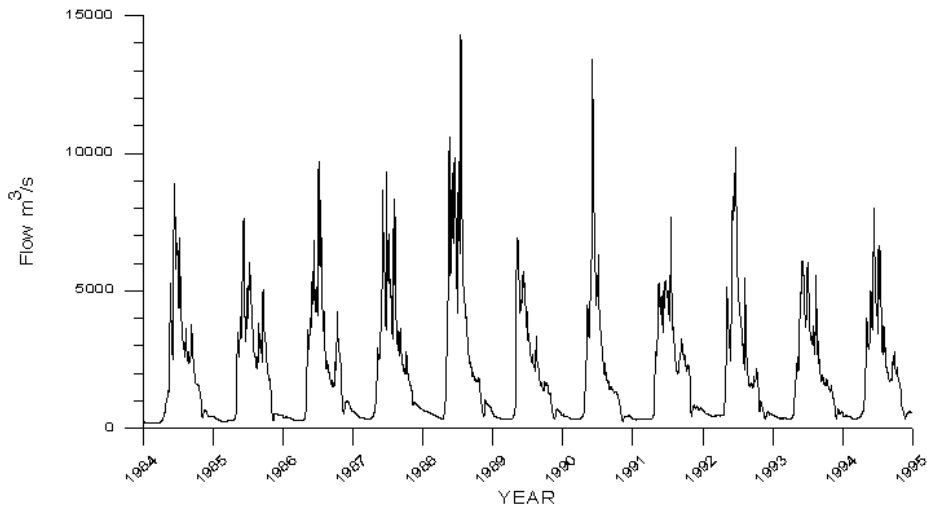
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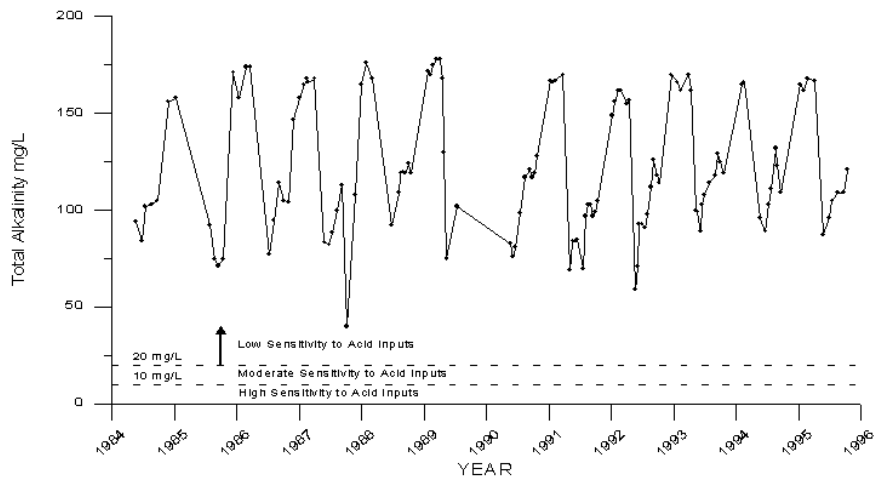
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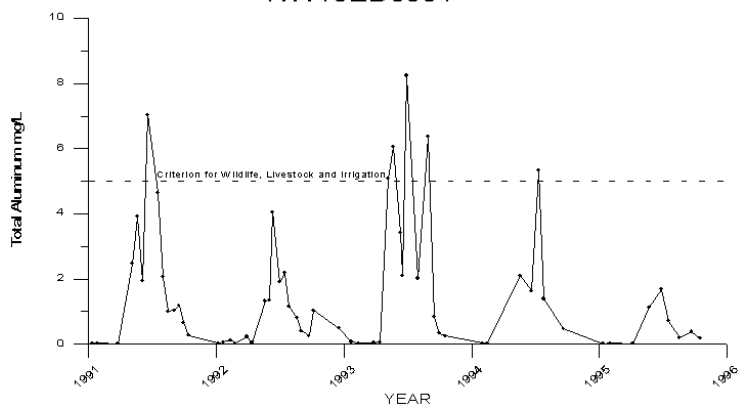


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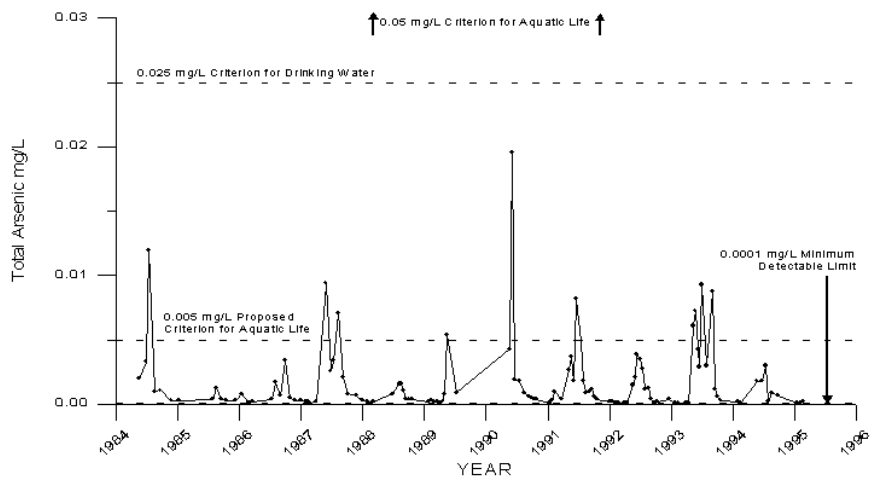
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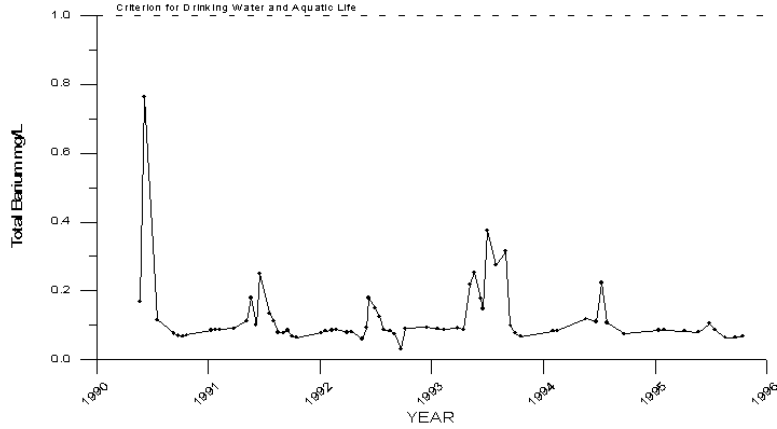


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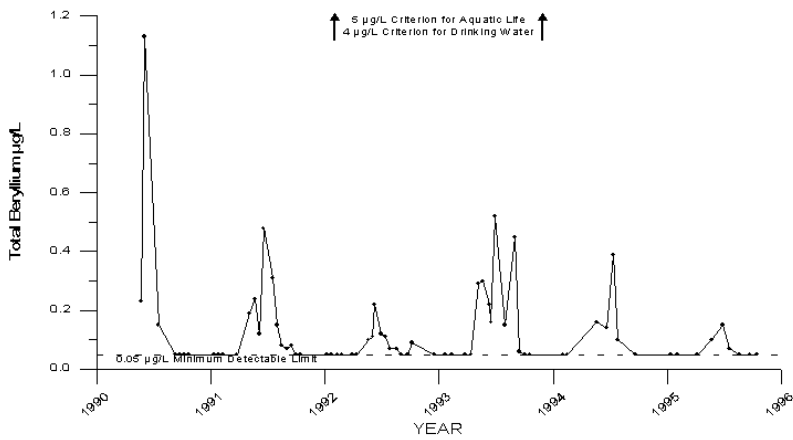
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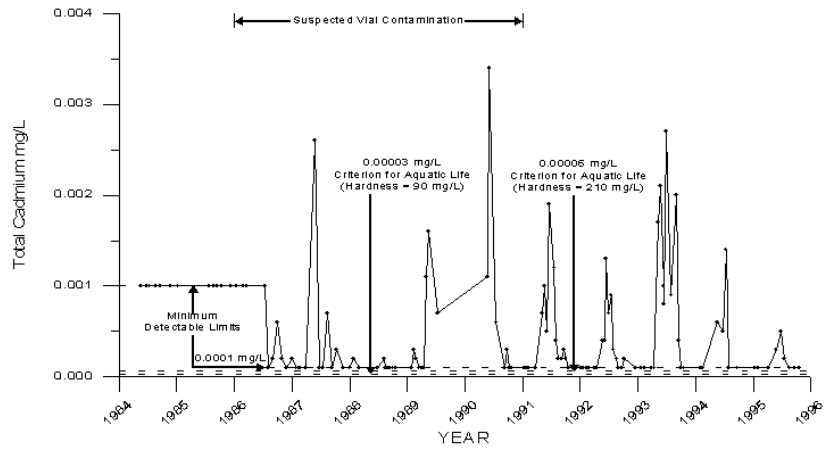
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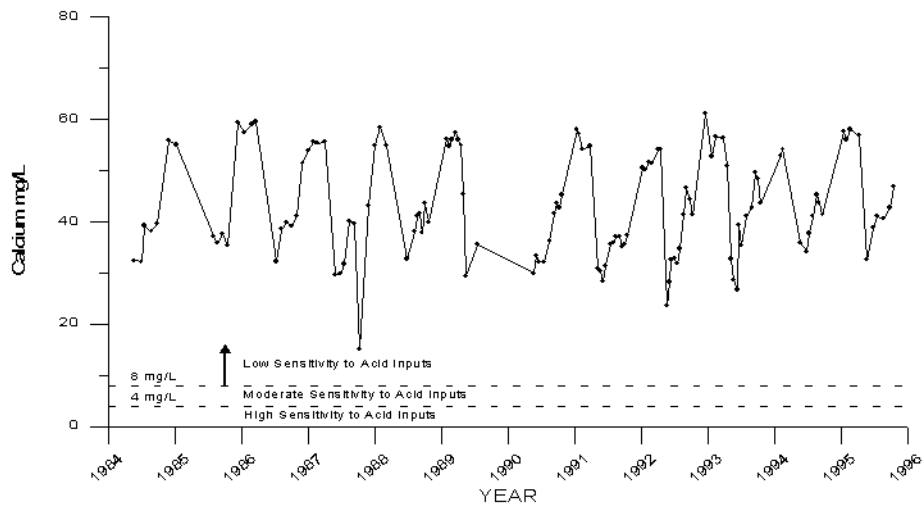
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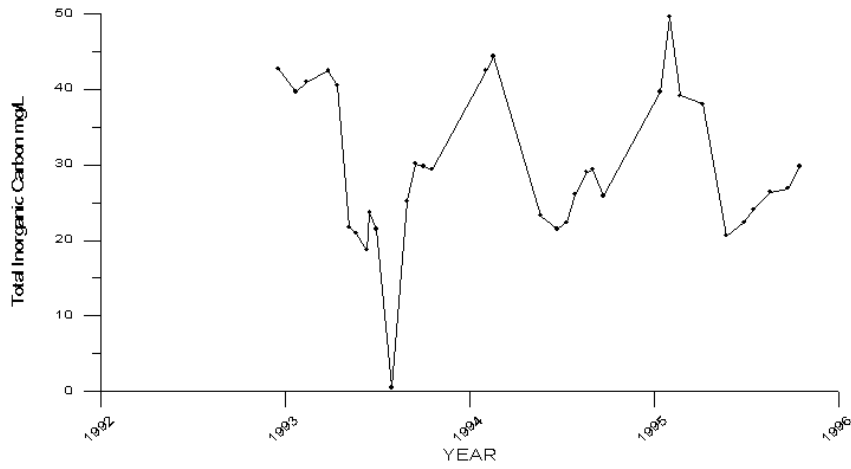
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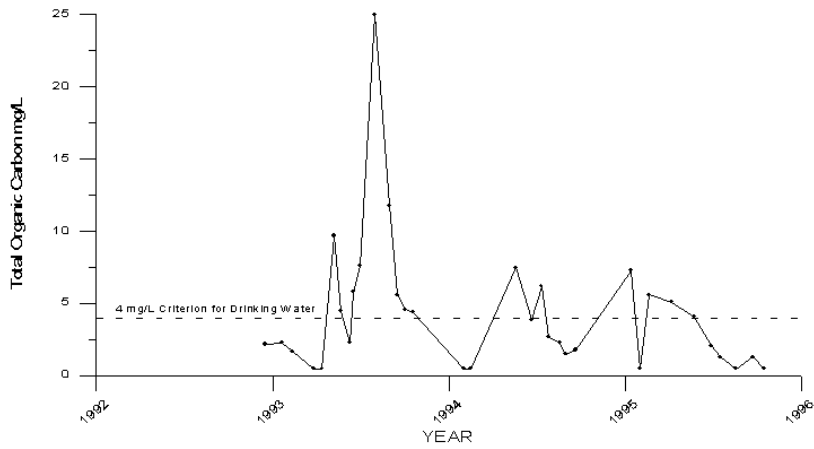
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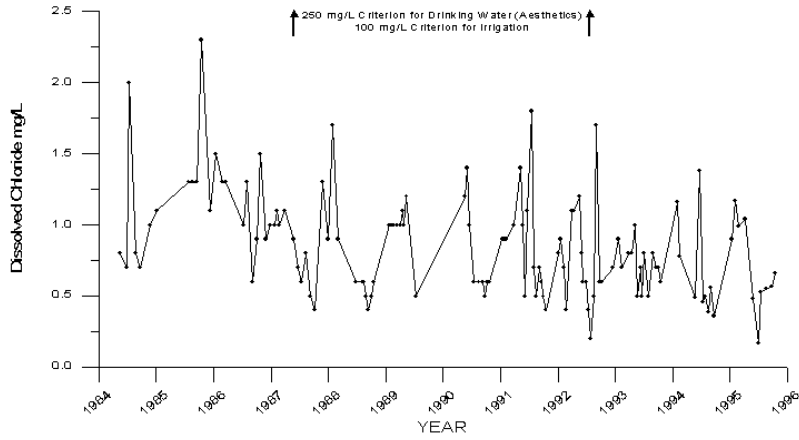
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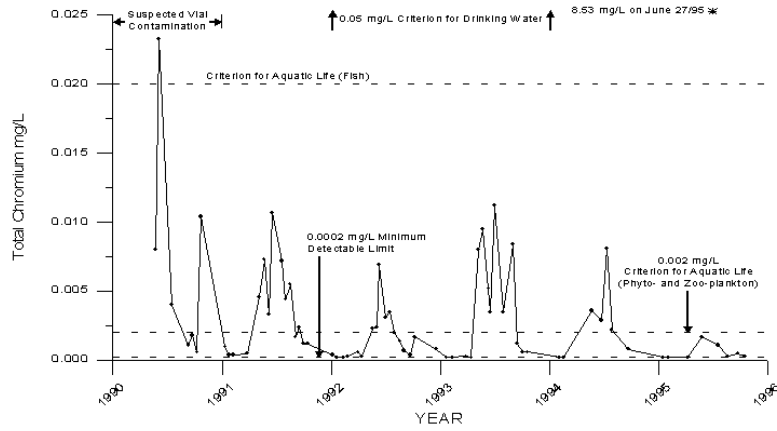
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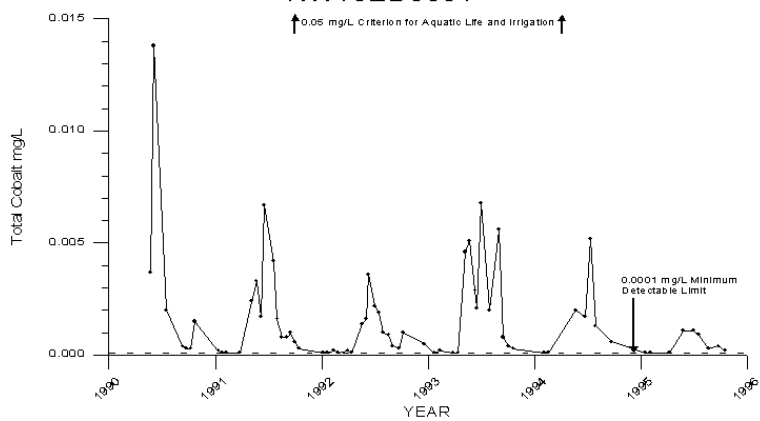
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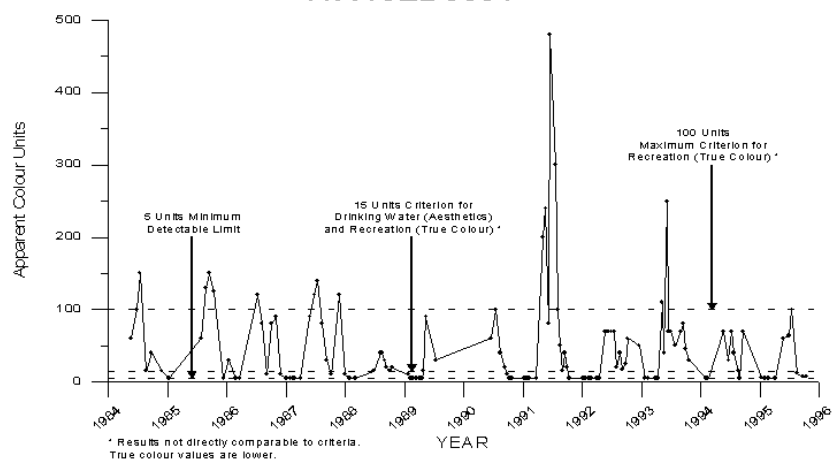
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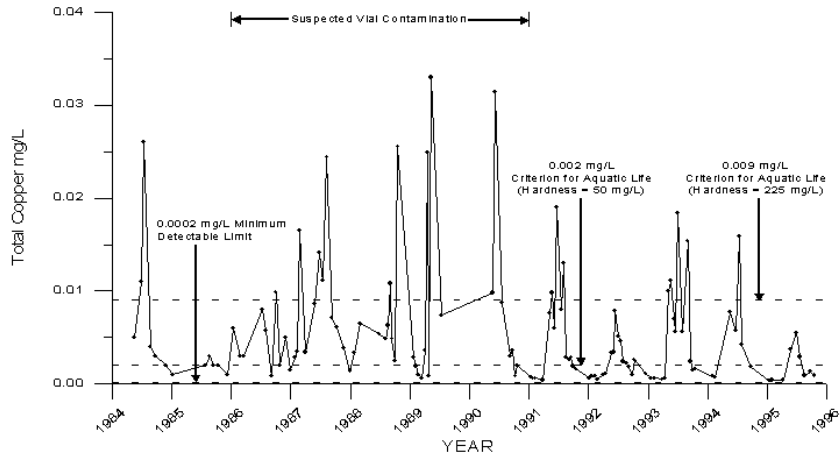
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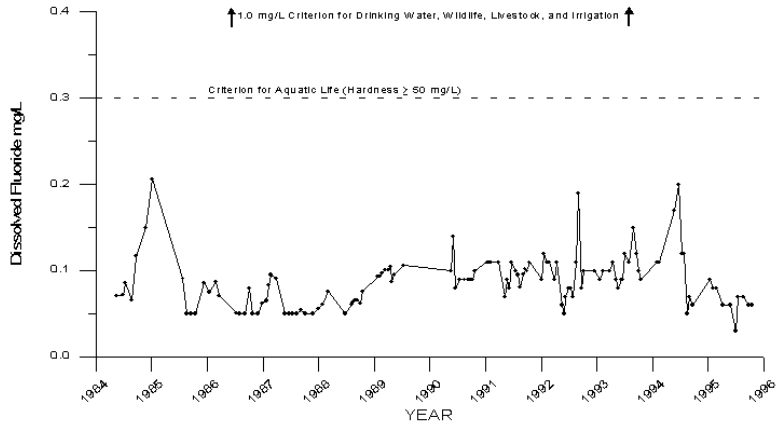
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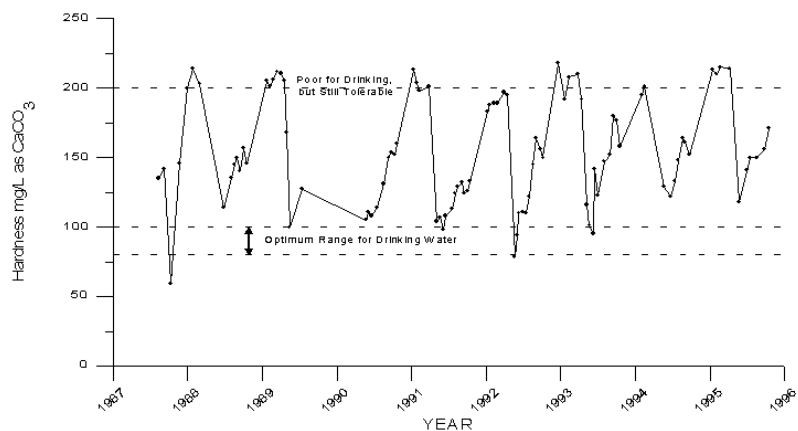
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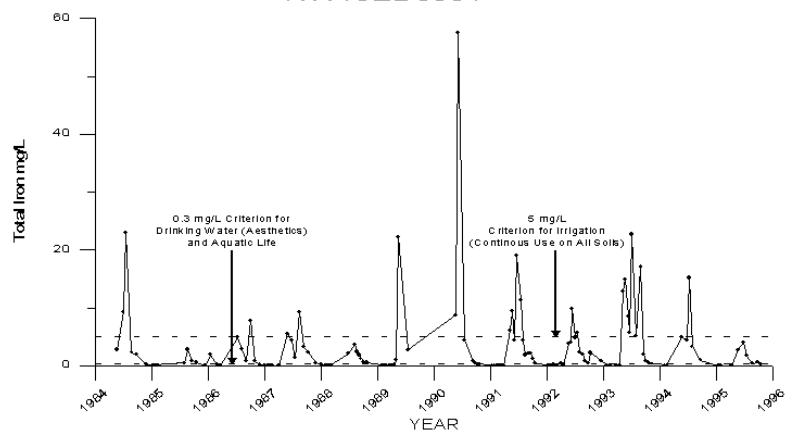




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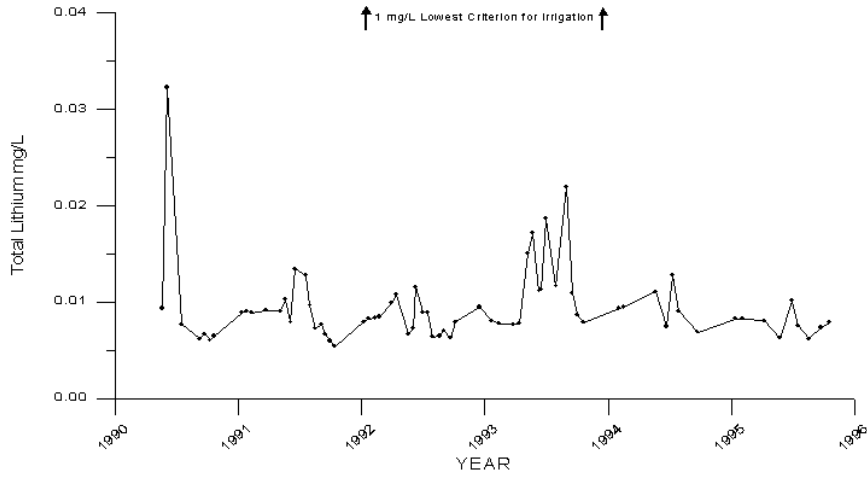


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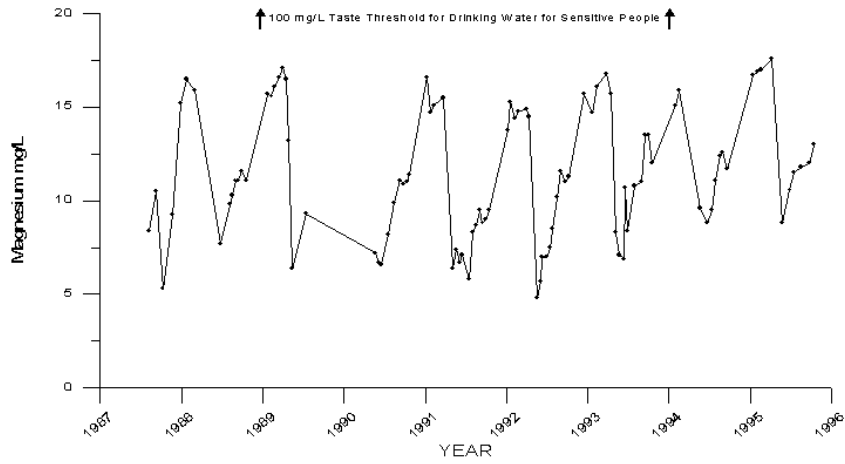
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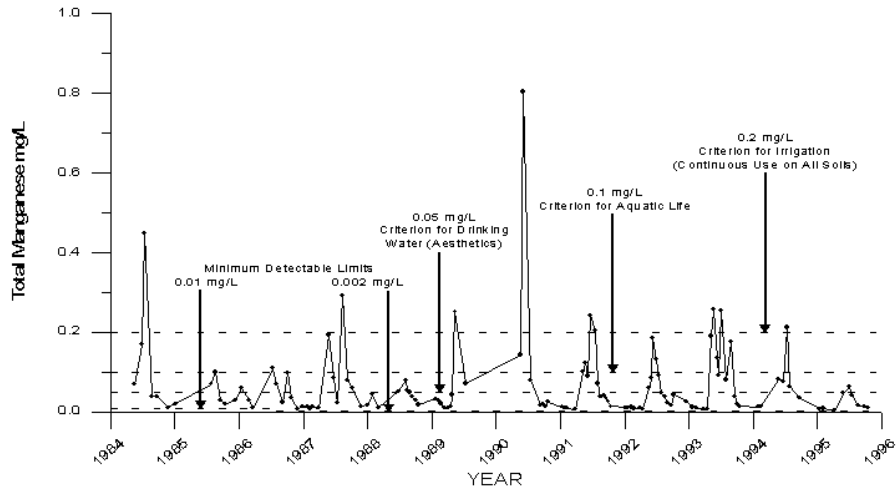
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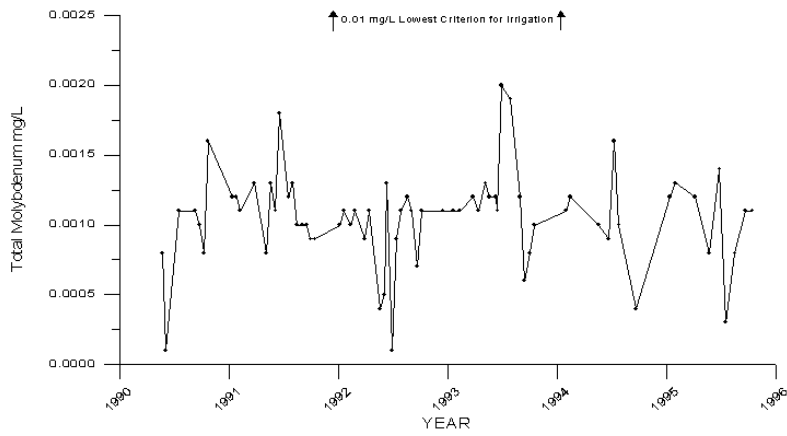
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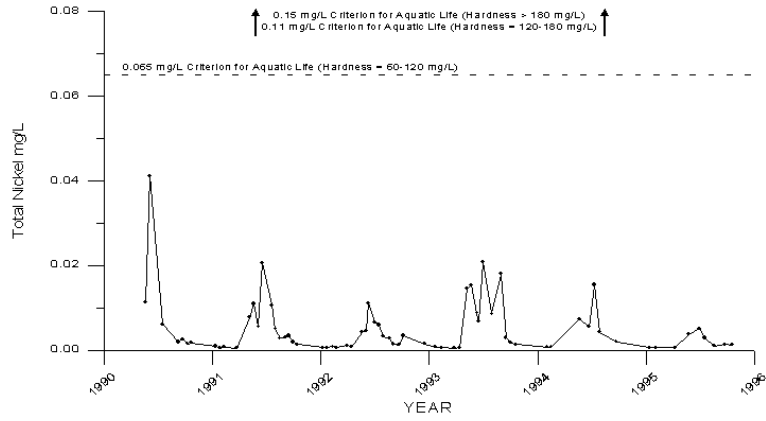
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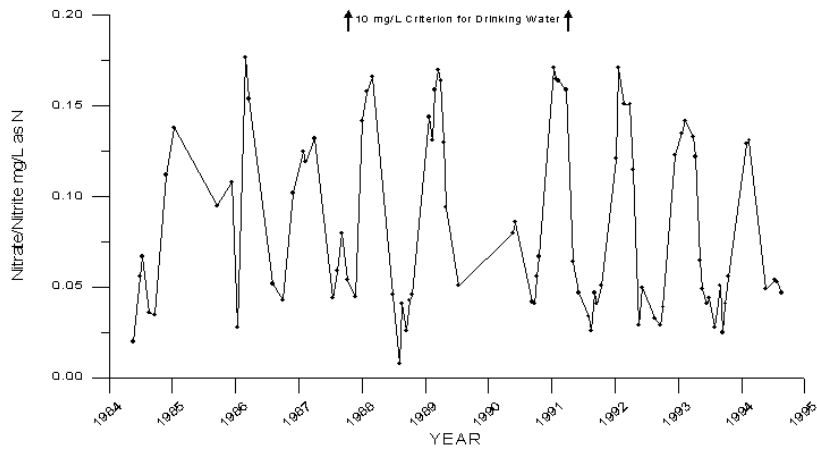
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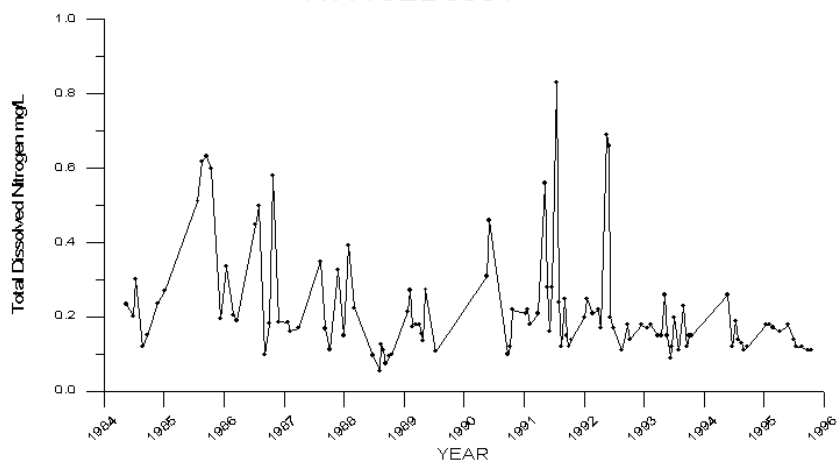
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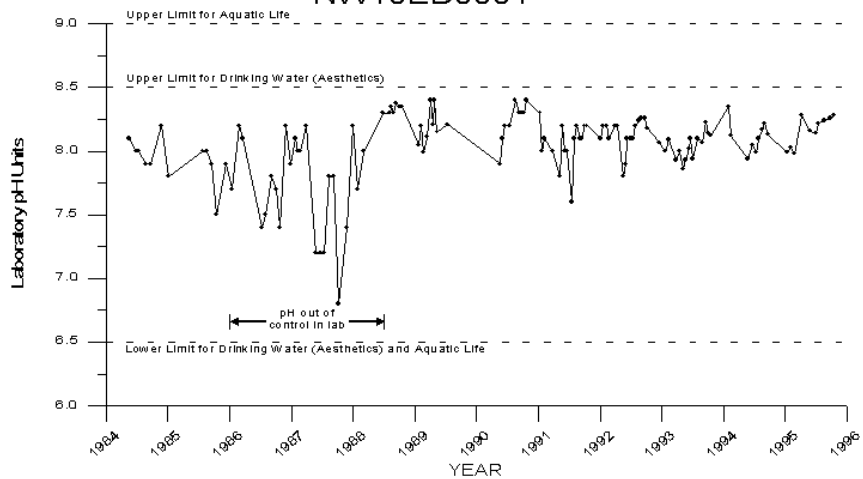
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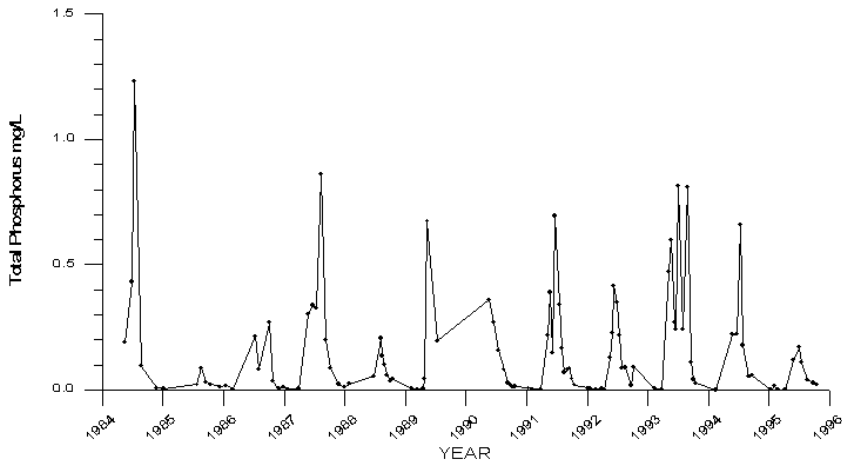
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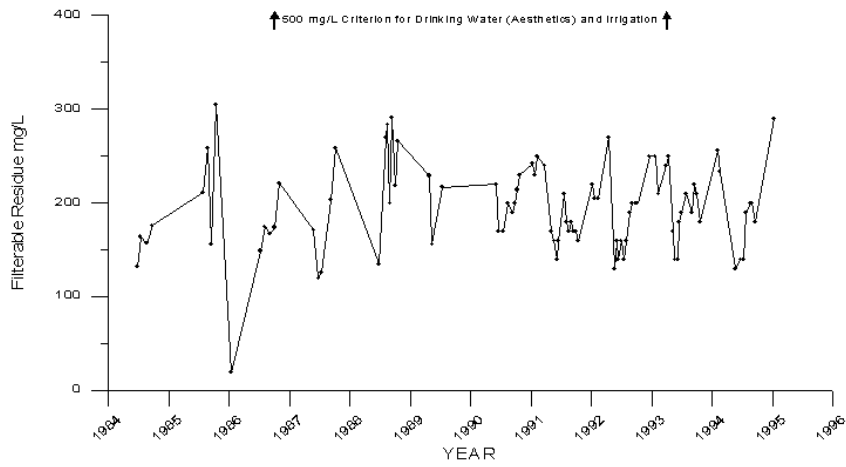
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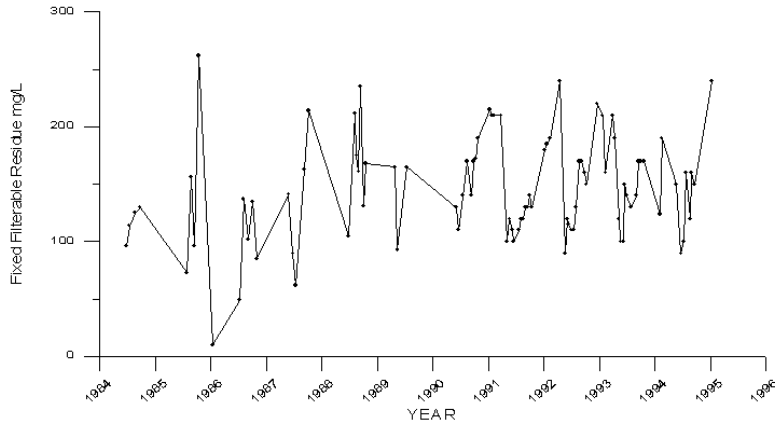
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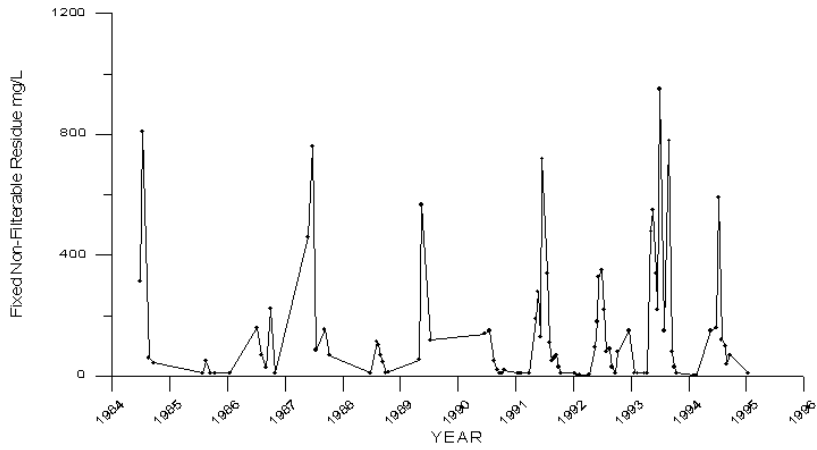
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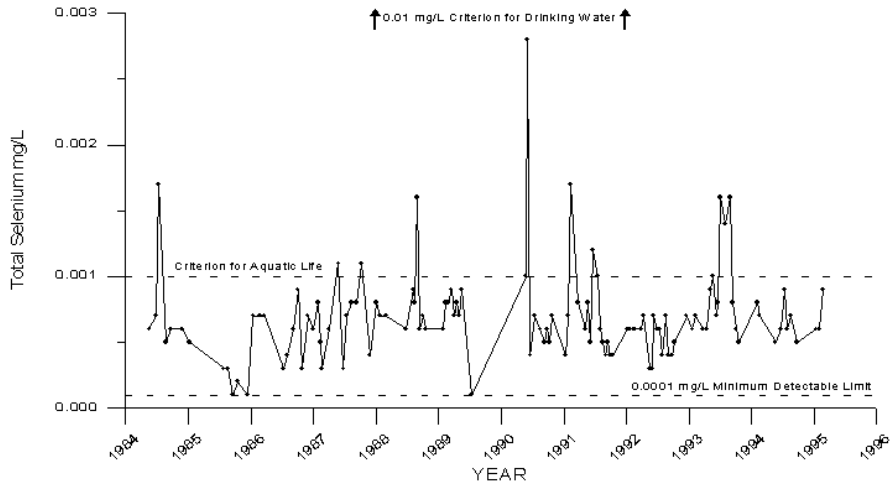
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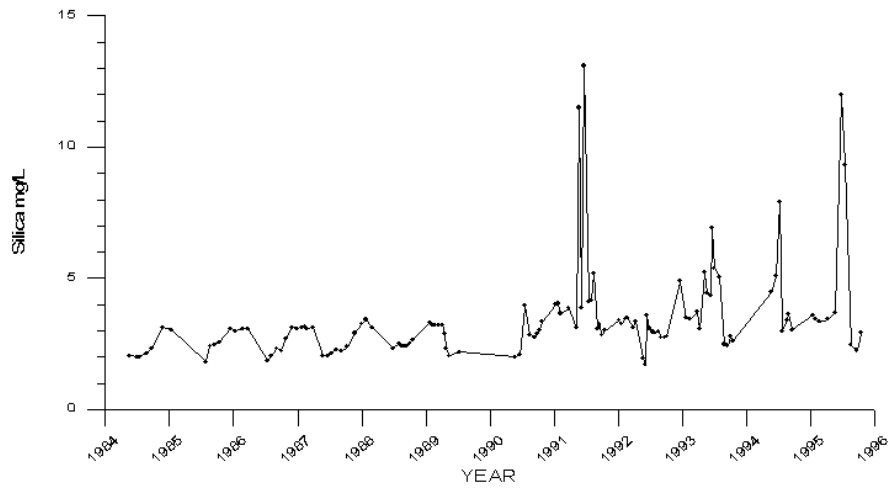
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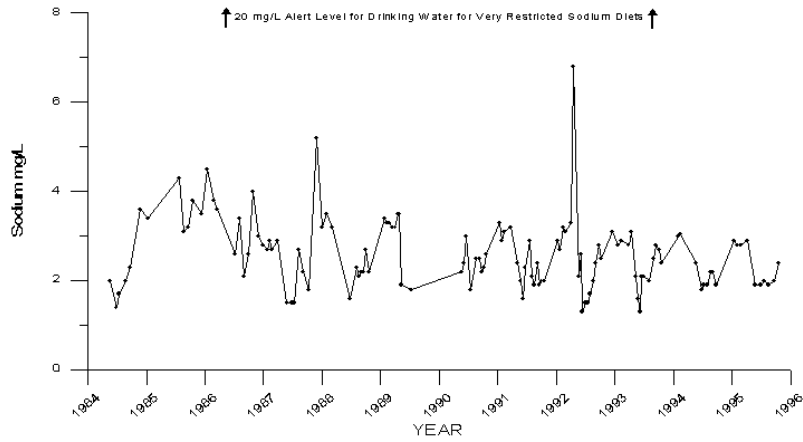
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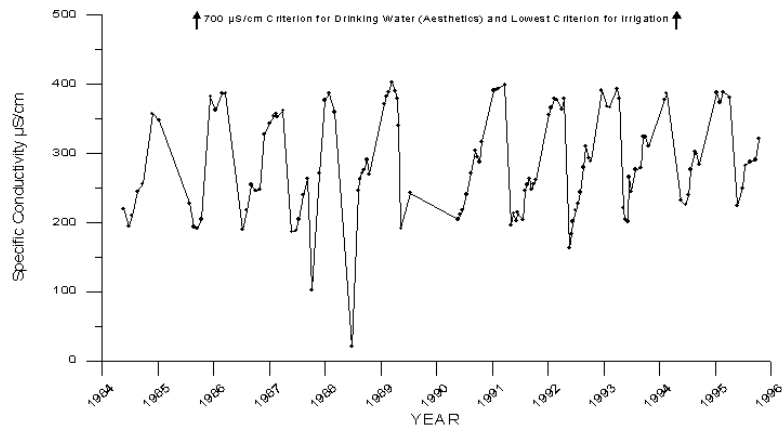
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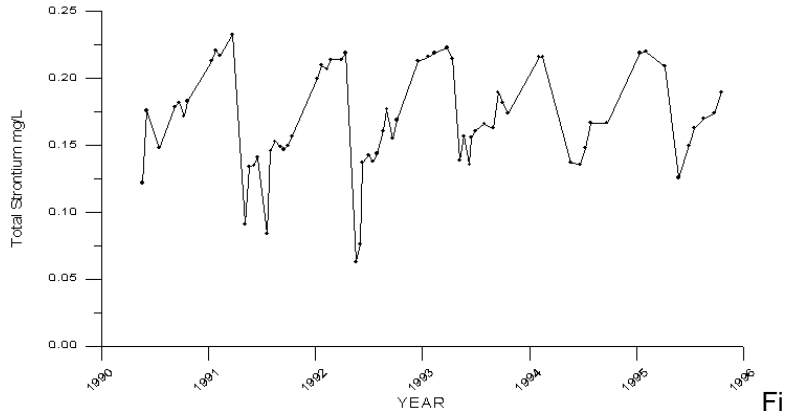
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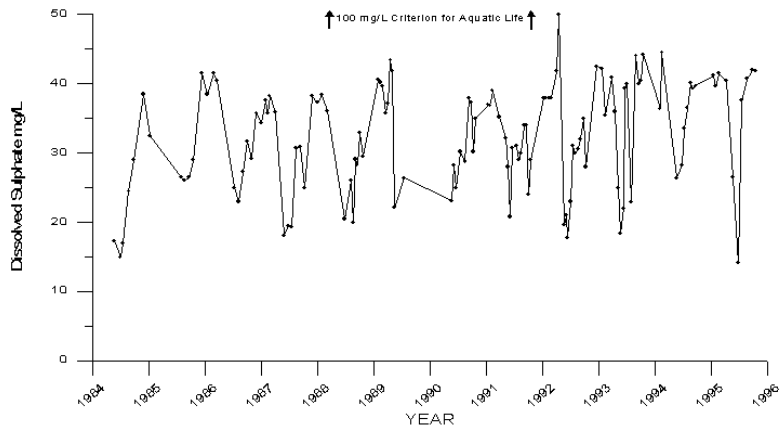
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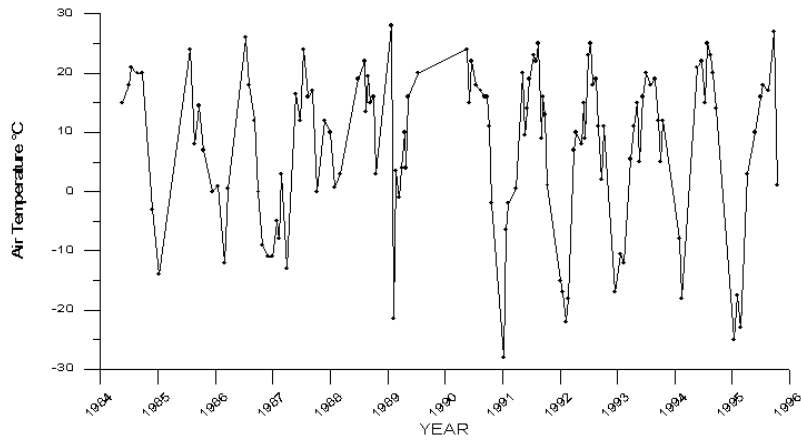
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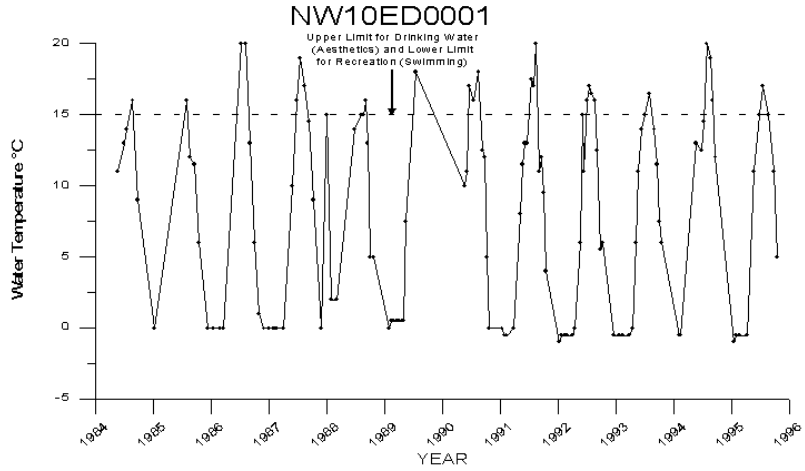


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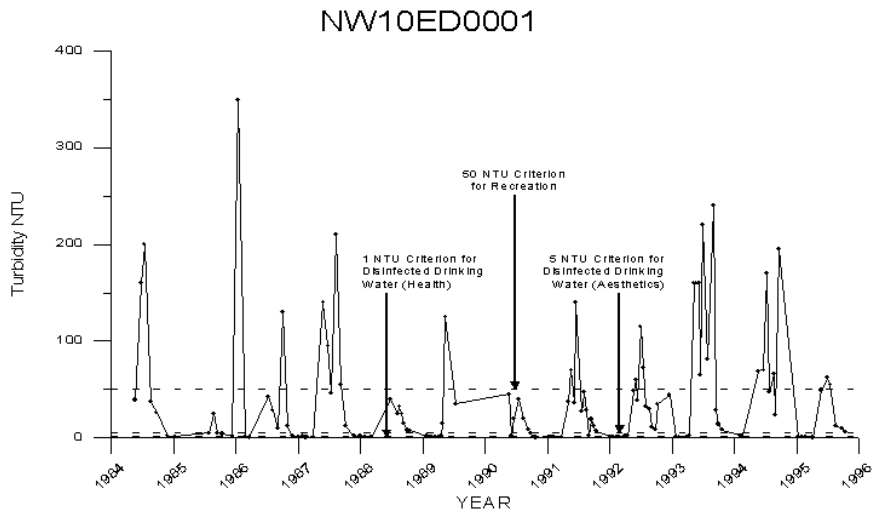
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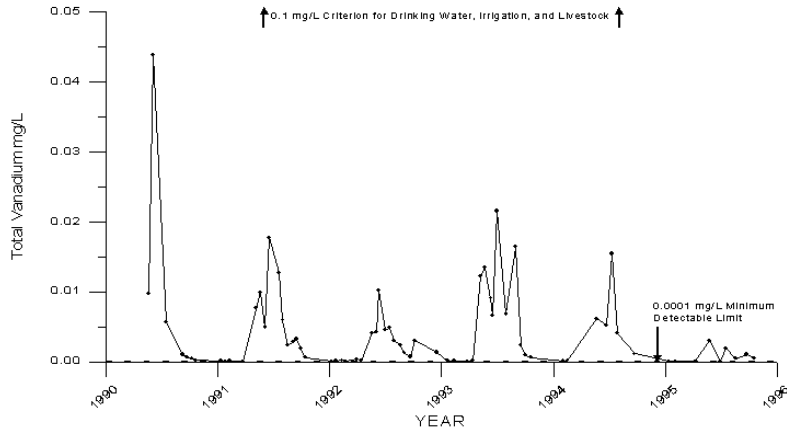
# LIARD RIVER AT FORT LIARD



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