PRELIMINARY REPORT ON NITRATE CONCENTRATIONS IN BASE FLOW IN RESIDENTIAL AND GOLF COURSE TRIBUTARIES TO BARTON CREEK

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ABSTRACT

Monitoring water quality in Barton Creek tributaries has been conducted to identify local effects of different land use types and to catch changes in water quality before they impacted the mainstem. This program has been revised to evaluate specific tributaries where a trend in water quality was determined and to attempt to correlate these trends to changing watershed factors. Baseflow water chemistry from eleven tributaries indicated nitrate nitrogen is increasing in general and not statistically related to flow changes. This increase has occurred in watersheds that were otherwise static in major construction projects and may reflect practices such as wastewater disposal or fertilization. Some of the baseflow nitrate data has been above TCEQ Clean Rivers screening criteria for nutrients (3.5 mg/L nitrate nitrogen).

INTRODUCTION

Monitoring water quality on a local level in Barton Creek tributaries was instituted in 1992 to identify local effects of different land use types. Effects can often be observed earlier in tributaries than in the mainstem, whereas dilution from undeveloped subwatersheds can possibly mask effects until cumulative impacts are irreversible.

Initial results were documented in the 1997 Barton Creek Report, indicating potentially significant differences in many parameters across tributary watersheds. The Barton Creek Canyon Study was initiated to determine how urbanization and wastewater disposal is affecting tributary water quality and how tributary water chemistry is affecting Barton Creek water chemistry and algae growth. The Canyon Update Report (2002) addressed the main objective of this monitoring by examining statistical differences between water chemistry parameters collected in 30 tributaries over the ten-year period between 1992-2001. This analysis showed that several of these tributaries have increasing and higher than expected nitrate/nitrite nitrogen concentrations. Monitoring was continued on specific tributaries to verify the previously observed trend. The following report documents the additional data and potential watershed factors that may be related to trends in tributary water quality.

METHODS

Sampling Protocol

Monitoring of baseflow water chemistry in eleven tributaries continued from 2001 until April of 2003. Two undeveloped tributaries, Fitzhugh and White Branch Creek were monitored for reference conditions. Samples were collected by ERM personnel at the mouths of the tributaries quarterly until April of 2003.

Laboratory parameters measured were Total Suspended Solids, Nitrate/Nitrite as N, Ammonia as N, Dissolved Ortho Phosphorous, Fecal Coliform and Turbidity.

Field parameters measured include pH, Conductivity, Flow, Water Temperature and Dissolved Oxygen. Standard collection methods were employed to prevent contamination and ensure preservation of samples. Changes to the laboratory and field collection methods and equipment over the course of the monitoring period are documented in the Canyon Study Update (COA 2002).

Site Selection

Sites were selected based on results indicating increasing concentrations of nitrate/nitrites were included in this study. Table 1 lists the eleven tributaries and details of this monitoring. The majority of the watersheds of these tributaries had no major development or increases to impervious cover after 1995.

Analysis

Analyses were run using Microsoft Excel 97 for regression analysis and graphing. Statistica 5.1, 97 Edition (Stat-soft) was used for Analysis of Variance (ANOVA) to determine statistical difference between the groups. Tukeys Unequal N Honest Significant Difference analysis was used for post hoc verification of results. Error levels less than or equal to 5% was considered statistically valid.

RESULTS

Nitrate/Nitrite as N

Nitrate/nitrite as N concentrations do not appear to be increasing in the undeveloped watersheds monitored during this time. (Fig. 1) However, all of the nine tributaries designated as residential or golf course appear to have increasing concentrations of nitrate/nitrite. (Fig. 2, 3 and 4)

Graphically, the increases appear starting in 1998. Regression analyses trendlines show definite temporal increases. Statistical analyses were performed to compare the two time periods in question. By breaking the data up into two groups, with the first group representing values from the first half of monitoring and ending in December 1998, the second group beginning in January 1999 and including values until 2003, the statistical validity of these temporal increases were checked. Figures 5 and 6 graphically depict the statistical differences between the two time periods for these tributaries.

ANOVA tests on the mean nitrate values were run between the two time periods for each individual tributary. Golf course tributary results indicate that nitrate values are statistically higher ($p<0.05$) in the later time period (1999-2003) for CRT and LJST. (Fig. 5)

Fazio tributary did not show a statistical increase in nitrate concentrations at this time. Fazio has a well-established water quality pond above the monitoring site that could be contributing to stabilizing nitrate concentrations.

Residential tributaries showed the same trend to temporally increasing nitrate concentrations. ANOVA tests run indicate four out five tributaries show statistically higher ($p<0.05$) temporal nitrate concentration. The tributaries with increasing nitrate include Barton Creek West (BCW), Camelot (CAM), Lost Creek Residential (LCR), Lost Creek Waterfall (LCW) and Ringtail Ridge (RRC) tributaries. Rob Roy Tributary (RRT) does not show statistically significant increase in nitrate values between the two time periods. (Fig. 5 & 6)

Regression analyses between flow and nitrate concentration show no consistently significant relationships. Analyses were run adjusting for flows, including only nitrate values that have flow measurements within one week of sample collection date. This is approximately 60% of the total samples.

Spearman nonparametric analysis of all developed tributaries grouped together shows that nitrate concentrations have a stronger statistical relationship to date than to flow, although there is a correlation to both. Individual analyses of the tributaries have varying results. Camelot and Lost Creek Waterfall show equal correlation to both flow and date. Barton Creek West, Crenshaw, Fazio, Ringtail Ridge and Rob Roy tributaries have stronger relationships to time, where the nitrate concentrations are increasing over time. However, Leif Johnson Spring and Lost Creek Residential tributaries have a stronger correlation to flow. Also in these tributaries, the nitrate concentrations increase as the flow increases.

Table 2 shows individual results for each tributary. No increases in fecal coliform, phosphates, ammonia or turbidity appear in these developed tributaries.

CONCLUSIONS

Baseflow nitrate concentrations in developed Barton Creek tributaries appear to be increasing on a temporal basis. Since only a slight statistical correlation to flow exists in the case of only a limited number of tributaries, increases in natural or anthropogenic inputs in the tributaries where increasing nitrate concentrations may be occurring. Possible sources include increased use of fertilizers, increasing traffic flows and increases in pet waste. Leaking wastewater lines could certainly contribute to increases in nutrients, but with no increases in fecal coliform, ammonia or phosphates, this is an unlikely source.

Alterations in management practices could be affecting nitrate concentrations. During 1999, the management of Barton Creek West Properties started using the north field for effluent irrigation. This particular field is closer to the tributary that was being monitored; therefore increases in constituents could possibly be entering the tributary faster and at higher levels than in previous years.

The nitrate concentration in the golf course tributaries, Crenshaw and Leif Johnson Spring Tributary, had higher mean concentrations than the other development type tributaries (Figures 2,3 and 4). This result was also noted in storm water runoff from golf courses and documented by the City of Austin's' Water Quality Monitoring program (COA 2003). It is likely that golf courses drainages have increased nutrients during baseflow and stormflow conditions. One exception to this occurrence was the Fazio tributary which did not show a statistical increase in baseflow nitrate concentrations at this time. However, Fazio has a well-established water quality pond above the monitoring site that could be contributing to stabilizing nitrate concentrations. Crenshaw Tributary does not have a water quality pond.

These tributaries typically have seasonal low flow conditions and drain very small watersheds: therefore, even though the nitrate concentrations are high and increasing, they do not contribute significantly to mainstem Barton Creek baseflow individually.

This monitoring program has shown that nitrate concentrations in already developed tributaries is not necessarily static, but in the case of the tributaries leading to Barton Creek, can increase to levels that approach and even exceed TCEQs Screening Criteria of 3.5 mg/l (TCEQ 2002)
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REFERENCES:

City of Austin. 2002. Barton Creek Canyons Study Update. Draft
City of Austin. 2003. Preliminary report on Storm Water Runoff from Golf Courses. Draft

Table1. Barton Creek Tributaries

Name	**Development and Wastewater Type**	**Acres/ %Impervious cover**	**Number of samples**	**Dates**	**Reason for Continued Monitoring**
Barton Creek West	Residential Effluent irrigation	239/ 8.5	102	4/12/95-5/22/03	Inc. NO3
Leif Johnson Spring Tributary	Golf effluent irrigation	33/ 4.6	69	4/20/93-4/21/03	Inc NO3
Rob Roy Tributary	Residential septic	280/ 14.9	39	4/20/93-4/21/03	Inc NO3
Fitzhugh Tributary	Undeveloped	3123/ 1.5	65	4/7/94-5/22/03	Reference
White Branch	Undeveloped	737/ 0.9	28	6/17/92-4/21/03	Reference
Lost Creek Residential	Residential central	173/ 8.9	68	2/7/94-2/12/03	Inc NO3
Lost Creek Waterfall	Residential Central	19/ 17.2	87	5/5/93-2/12/03	Inc NO3
Ringtail Ridge	Residential Central	71/ 16.2	76	5/5/93-2/12/03	Inc NO3
Camelot Tributary	Residential Septic	134/ 12.4	33	5/28/93-1/27/03	Inc NO3
Crenshaw Tributary	Golf Course effluent irrigation	15/ 1.1	80	1/15/93-11/13/03	Inc NO3
Fazio Tributary	Golf Course effluent irrigation	123/ 8.3	43	4/20/92-4/21/03	Inc. NO3

Table 2. Individual Tributary results when adjusting for flow

	BCW	CAM	CRT	Fazio	LCR	LCW	LJST	RRC	RRt
NO3 corr. w/flow	O=0.42 P<0.0001	O=0.35 P=0.08							
NO3inc.temporally adjusted for flow	P<0.0001 r2=0.46	P=0.08 r2=0.14							
Flow decreasing temporally	P=0.03 r2=0.06	P=0.07							

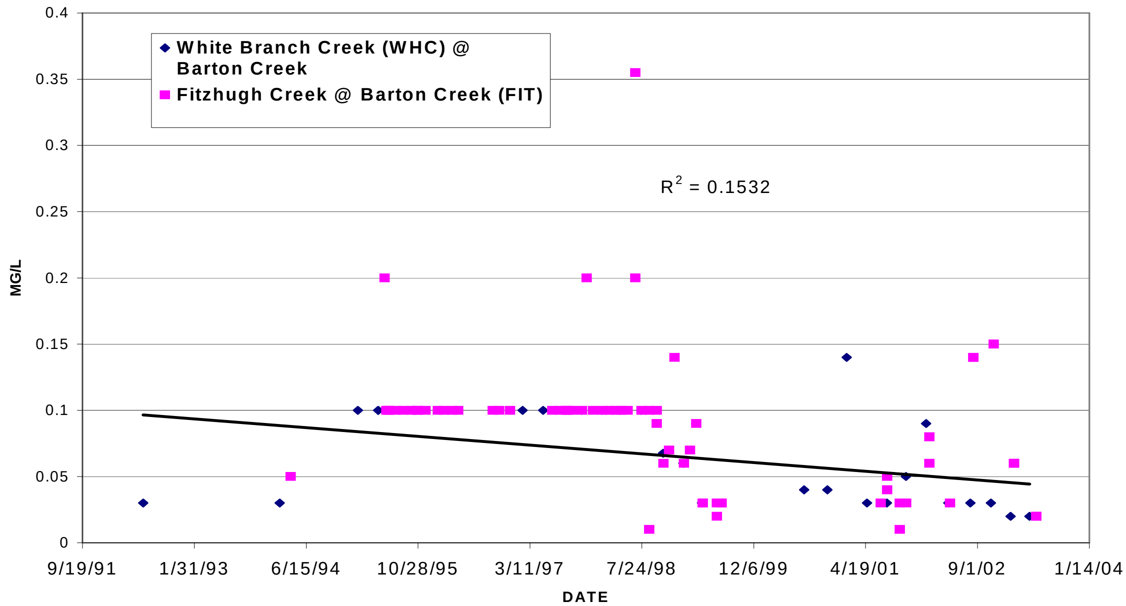

Figure 1. Temporal Nitrate Values In Undeveloped Tributaries to Barton Creek

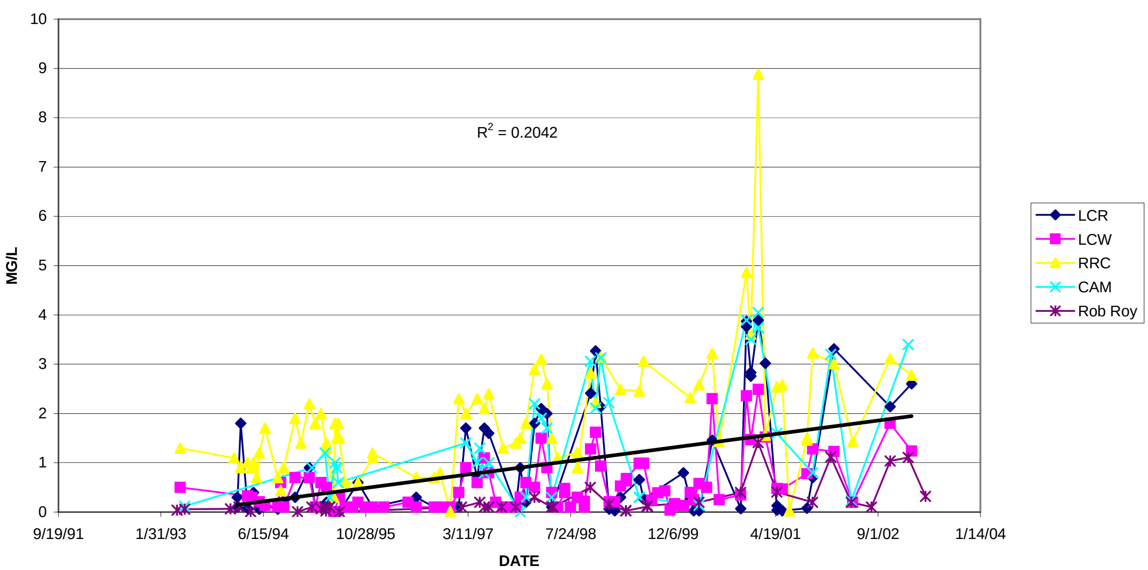

Figure 2. Temporal Nitrate values in Residential Watersheds Tributaries to Barton Creek

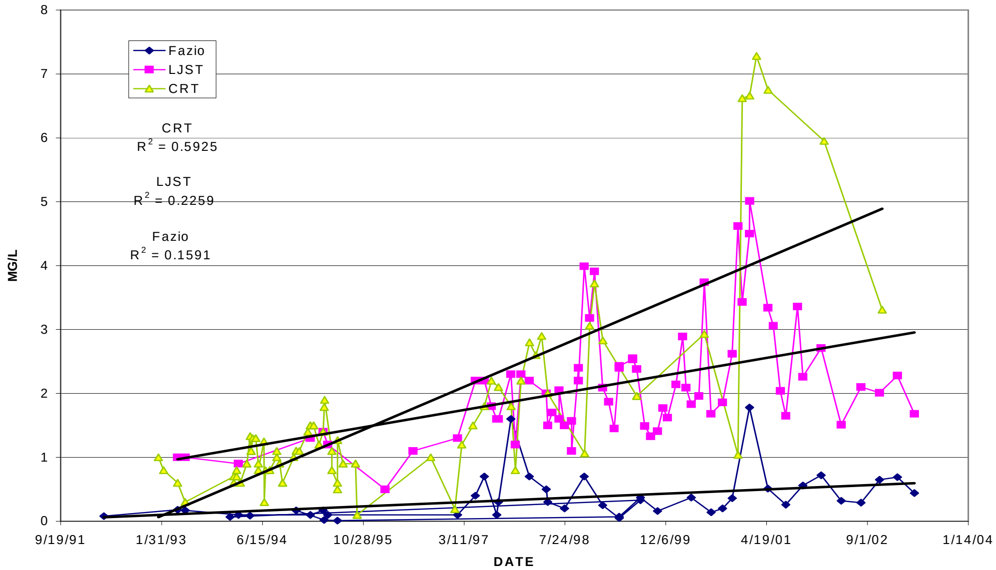

Figure 3. Temporal Nitrate values in Golf Course watershed tributaries to Barton Creek

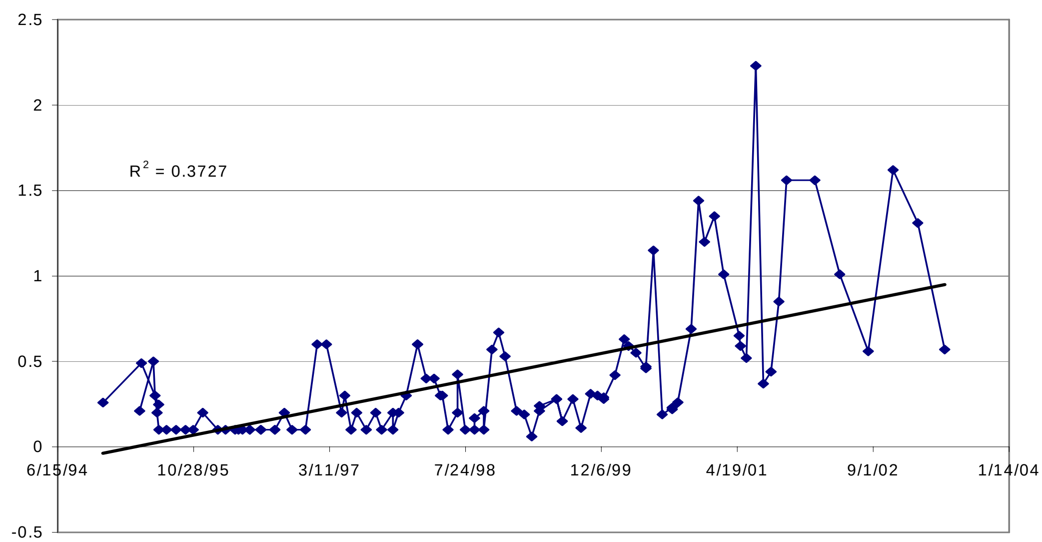

Figure 4. Temporal Nitrate values in Barton Creek West Tributary to Barton Creek

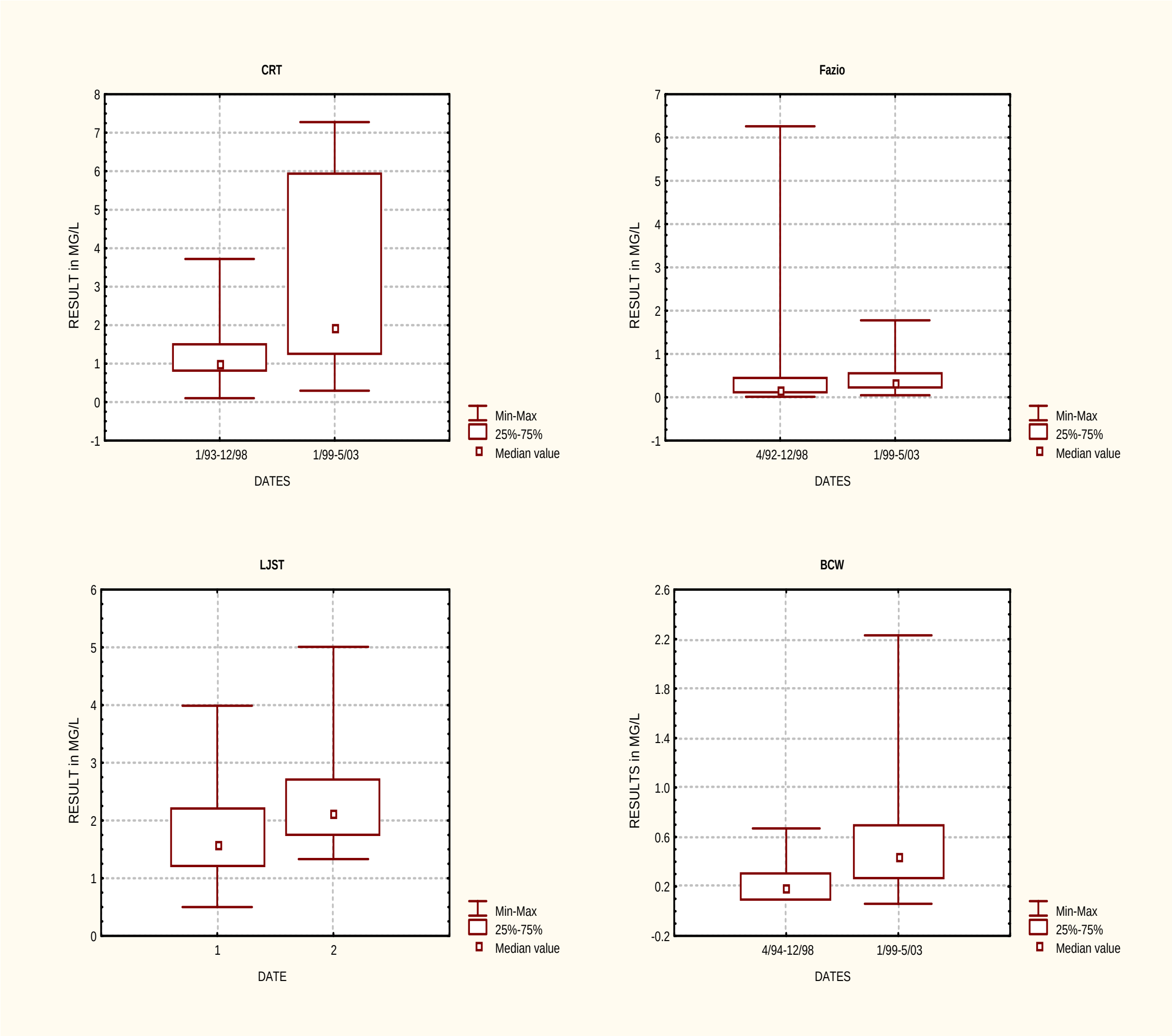

Figure 5. Graphs of the mean nitrate values in golf and residential effluent irrigated tributaries to Barton Creek

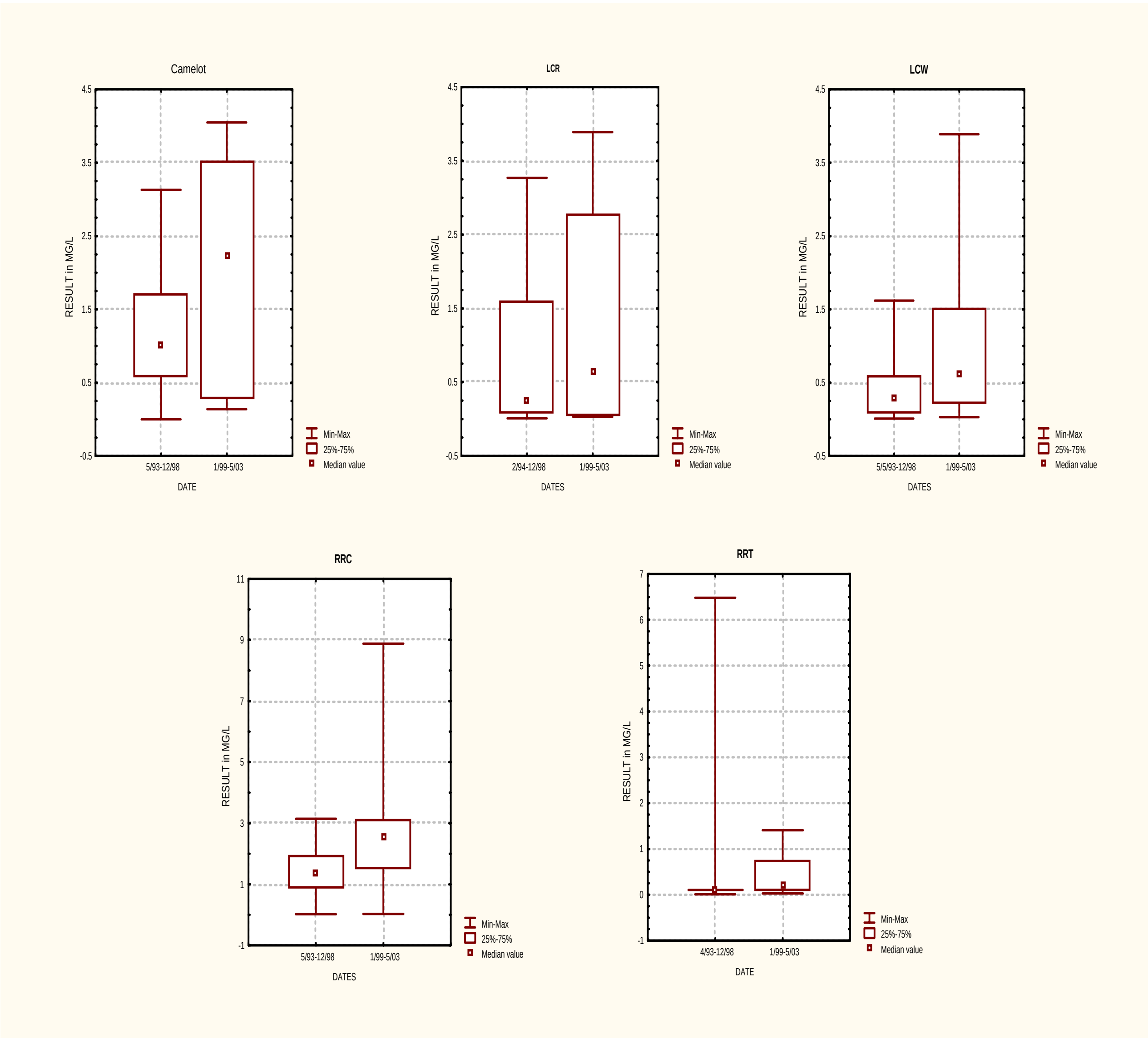

Figure 6. Graphs of the mean nitrate values in residential tributaries to Barton Creek