A P P E N D I X C

McArthur River Mine Open Cut Project PER

Additional Water Quality Assessment

Prepared for

McArthur River Mining Pty Ltd

18 May 2006

42625552

Contents

Introduction

SECTION 1

A draft Environmental Impact Statement (EIS) has been prepared for the McArthur River Mine Open Cut Project. The draft EIS was made available for public review and comment from 14 August to 21 October 2005.

In response to the public review, fourteen written submissions were received. These comments were address in the EIS Supplement which was submitted to the NT Office of Environmental and Heritage (OEH) on 14 December 2005.

OEH has subsequently sought further information and points of clarification which were given to McArthur River Mining (MRM) on 6 February 2006. This report provides a response to the further information request. It has been divided into sections corresponding to the topics of the information request. For each section the request is given in bold italics and the responses follow.

2.1 Influence of Surprise and Barney Creeks to Water Quality in the McArthur River

2.1.1 Overview

Previous water quality information presented in the Draft EIS and subsequent EIS Supplement primarily focused on review of total metals concentrations. In response to the above question from OEH, this assessment has reviewed filtered metal concentrations as a measure of bioavailability of metal contaminants and risk to aquatic ecosystems. It has also considered the hardness of the receiving waters for comparison of the surface water quality statistics against hardness-modified ANZECC (2000) water quality trigger levels for toxicants in freshwater ecosystems. The revised assessment is for water quality monitoring data between January 2003 and September 2005 to provide a reasonable measure of current baseline conditions and impacts. The available number of water quality results for this period was sufficient for statistical methods in accordance ANZECC (2000) recommendations.

2.1.2 Water Quality Data and Assessment

Surface water monitoring data for the period January 2003 to September 2005 were assessed for this water quality review to provide a measure of current baseline water quality conditions and impacts with sufficient sample numbers for statistical analysis. Data were available for upstream and downstream surface water monitoring sites in McArthur River (SW7 and SW6), Surprise Creek (SW1 and SW2), and Barney Creek (SW 4, SW3 and SW5) as shown in Figure 12.7 of the Draft EIS. During this period sampling of surface water occurred weekly whenever water was present at the respective monitoring sites. As Barney Creek and Surprise Creek are smaller ephemeral streams (which produce less flow and for shorter periods than the McArthur River), fewer samples were available for these creeks. A statistical summary of the water quality data is given in Tables 2.1 and 2.2.

The number of available filtered metals concentrations results for the respective monitoring sites are shown in Figure 2.1.

Table 2.1

Water Quality Statistics Summary

McArthur River Mine 2003 - 2005 Water Quality Summary

Anzecc 2000 Freshwater Toxicant Trigger Values

	Median hardness McArthur River Upstream (SW7)	
	115 mg/L CaCO3	
	Default Trigger Value	**Hardness Modified TV**
	95% protection level	***95% protection level***
Copper	1.4	4.4
Lead	3.4	19
Zinc	8.0	25

Filtered Copper	**SW7 Upstream McArthur Rvr**	**SW6 Downstream McArthur Rvr**	**SW1 Upstream Surprise Ck**	**SW4 Upstream Barney Ck**
Count	153	148	104	66
Median	0.6	0.6	0.5	1.0
80th percentile	1.1	1.2	0.6	1.5
95th percentile	2.1	2.1	1.2	3.0
99th percentile	3.8	3.1	2.8	4.0
ANZECC HMTV	**4.4**	**4.4**	**4.4**	**4.4**

Filtered Lead	**SW7 Upstream McArthur Rvr**	**SW6 Downstream McArthur Rvr**	**SW1 Upstream Surprise Ck**	**SW4 Upstream Barney Ck**
Count	153	148	104	66
Median	0.04	0.06	0.07	0.36
80th percentile	0.2	0.3	0.3	1.0
95th percentile	0.6	0.9	0.9	3.0
99th percentile	1.2	2.9	23.1	12.7
ANZECC HMTV	**19**	**19**	**19**	**19**

Filtered Zinc	**SW7 Upstream McArthur Rvr**	**SW6 Downstream McArthur Rvr**	**SW1 Upstream Surprise Ck**	**SW4 Upstream Barney Ck**
Count	153	148	104	66
Median	1.2	1.4	2.4	2.1
80th percentile	3.2	3.6	4.3	7.5
95th percentile	8.5	8.3	15	63
99th percentile	32	25	66	144
ANZECC HMTV	**25**	**25**	**25**	**25**

Table 2.2

Hardness Water Quality Summary

MRM Surface Water Hardness (mg/L as $CaCO_3$) 1995 to 2003

	SW1 Surprise Creek Upstream	**SW4 Barney Creek Upstream**	**SW6 McArthur River Downstream**	**SW7 McArthur River Upstream**
count	56	45	69	70
5% ile	12	10	34	25
10% ile	18	11	38	32
20% ile	**30**	**16**	**51**	**41**
30% ile	40	18	74	60
40% ile	63	19	90	82
50% ile	**88**	**21**	**150**	**115**
60% ile	240	23	199	156
70% ile	333	25	297	221
80% ile	**348**	**26**	**337**	**334**
90% ile	365	35	485	360
95% ile	375	40	508	399

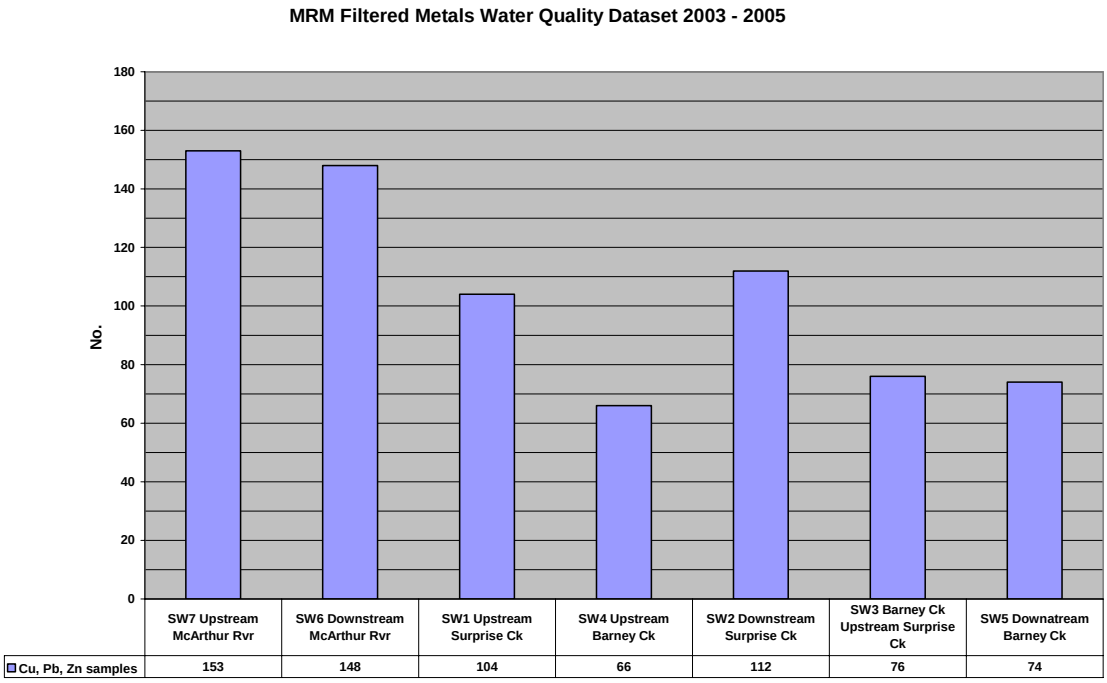


Figure 2.1

No. of Filtered Metal Concentration Results Available 2003 to 2005

No hardness concentration results were available for the period 2003 to 2005. Earlier surface water quality sampling from 1995 to 2003 included analysis of hardness concentrations (as mg/L $CaCO_3$). From the earlier monitoring dataset, 45 to 70 hardness results were available to define the median hardness of receiving waters. These results were used to undertake hardness modification of the default ANZECC water quality trigger values.

2.1.3 Assessment Methods

To evaluate the contribution of Surprise Creek and Barney Creek to water quality in the McArthur River, statistical percentiles of the datasets sets for each site were evaluated, and time-series plot comparisons between the sites was evaluated for filtered copper, lead and zinc concentrations.

Percentiles of filtered metals concentrations at key reference sites, and calculations of hardness modification of the default ANZECC trigger values (in accordance with ANZECC Table 3.4.3), were used for assessment of the receiving water quality risks to the protection of aquatic ecosystems (in accordance with decision tree for testing metals speciation against guideline values – ANZECC Figure 3.4.2). The comparison was based on a 95% protection level for freshwater aquatic ecosystems. In accordance with the recommendations in ANZECC (Volume 1, Section 7.4.4.2), the test data comparison was based on calculated 95^{th} percentiles of the monitoring data set.

2.1.4 Filtered Metals Variability

The percentile plots of filtered copper, lead and zinc (Figures 2.2, 2.3, and 2.4 respectively) show consistent variability across all monitoring sites (i.e. similar shaped percentile curves). This indicates that the filtered metals concentration are likely to be consistent with respect to flow conditions and does not show evidence of TSF seepage impacts (i.e. a distortion of the shape of the percentile curves between SW1 and SW2 and between SW4 and SW3 is not evident).

2.1.5 Spatial Variation and Influences on McArthur River Filtered Metals Concentrations

The McArthur River downstream site shows higher filtered metals concentration relative to the upstream McArthur River monitoring site, indicating an influence from potentially a number of sources including Surprise Creek, Barney Creek, within the McArthur River channel (possibly from natural mineralisation), or from Bull Creek (tributary on eastern side of the McArthur River). Bull Creek is relatively small and it would be expected that Bull Creek would have relatively minor, if any, influence on McArthur River filtered metals concentrations.

The upstream Surprise Creek monitoring site (SW1) shows slightly lower copper concentrations relatively to the upstream McArthur River site (SW7), and slightly higher lead and zinc concentrations. The downstream Surprise Creek monitoring site (SW2) shows a minor increase in copper concentrations relative to the upstream site, and relatively similar lead concentrations, and very small increase in zinc concentrations. Surprise Creek catchment is small relative to the McArthur River catchment, and in general the results show that Surprise Creek would have relatively minor impact on filtered metals concentrations in the McArthur River.

The upstream Barney Creek monitoring site (SW4) has distinctly higher concentrations of copper and lead relative to the upstream McArthur River and Surprise Creek sites. The upstream site can be considered to be a measure of relatively natural runoff (excepting perhaps a minor influence from the Carpentaria Highway) and the higher metals concentrations are likely to be attributable to natural geology and geochemistry of the catchment. The “middle reach” Barney Creek monitoring site (SW3) shows filtered copper, lead and zinc concentrations higher than the upstream site, indicating an influence within the reach between the two sites due to natural and/or unnatural sources. Mining activity is a potential influence on this increase in filtered metals concentrations. However, it is also known that both teena dolomite and dolamitic shale outcrop along on the bed of Barney Creek in several locations in this reach, and the increase in metals concentrations would be influenced from the natural creek bed geology.

The downstream Barney Creek monitoring site (SW5 – downstream of the Surprise Creek junction) shows lower filtered concentrations of copper, lead and zinc relative to the Barney Creek monitoring site upstream of the Surprise Creek junction. This indicates that lower concentrations of metals in Surprise Creek are likely have a diluting influence on the filtered metals concentrations in the Barney Creek reach downstream of the Surprise Creek junction. The net downstream Barney Creek filtered metals concentrations are all above the upstream and downstream McArthur River filtered metals concentrations most notably for lead and zinc. This indicates that the Barney Creek (including runoff from the

undisturbed catchment upstream of the mine) is likely to be one of the influences on downstream McArthur River metals concentrations.

2.1.6 Temporal Variability of Filtered Metals Concentrations

The McArthur River downstream site shows higher filtered metals concentration relative to the upstream McArthur River monitoring site, indicating an influence from potentially a number of sources including Surprise Creek, Barney Creek, within the McArthur River channel (possibly from natural mineralisation), or from Bull Creek (tributary on eastern side of the McArthur River). Bull Creek is relatively small and it would be expected that Bull Creek would have relatively minor, if any, influence on McArthur River filtered metals concentrations.

The upstream Surprise Creek monitoring site (SW1) shows slightly lower copper concentrations relatively to the upstream McArthur River site (SW7), and slightly higher lead and zinc concentrations. The downstream Surprise Creek monitoring site (SW2) shows a minor increase in copper concentrations relative to the upstream site, and relatively similar lead concentrations, and very small increase in zinc concentrations. Surprise Creek catchment is small relative to the McArthur River catchment, and in general the results show that Surprise Creek would have relatively minor impact on filtered metals concentrations in the McArthur River.

The upstream Barney Creek monitoring site (SW4) has distinctly higher concentrations of copper and lead relative to the upstream McArthur River and Surprise Creek sites. The upstream site can be considered to be a measure of relatively natural runoff (excepting perhaps a minor influence from the Carpentaria Highway) and the higher metals concentrations are likely to be attributable to natural geology and geochemistry of the catchment. The “middle reach” Barney Creek monitoring site (SW3) shows filtered copper, lead and zinc concentrations higher than the upstream site, indicating an influence within the reach between the two sites due to natural and/or unnatural sources. Mining activity is a potential influence on this increase in filtered metals concentrations. However, it is also known that both teena dolomite and dolamitic shale outcrop along on the bed of Barney Creek in several locations in this reach, and the increase in metals concentrations would be influenced from the natural creek bed geology.

The downstream Barney Creek monitoring site (SW5 – downstream of the Surprise Creek junction) shows lower filtered concentrations of copper, lead and zinc relative to the Barney Creek monitoring site upstream of the Surprise Creek junction. This indicates that lower concentrations of metals in Surprise Creek are likely have a diluting influence on the filtered metals concentrations in the Barney Creek reach downstream of the Surprise Creek junction. The net downstream Barney Creek filtered metals concentrations (after mixing with Surprise Creek) are all above the upstream and downstream McArthur River filtered metals concentrations most notably for lead and zinc. This indicates that the Barney Creek (including runoff from the undisturbed catchment upstream of the mine) is likely to be one of the influences on downstream McArthur River metals concentrations.

2.1.7 Sulphate and Electrical Conductivity Influences

Percentile plots of electrical conductivity (Figure 2.8) and sulphate concentrations (Figure 2.9) show marked difference in the shape of the percentile curves between the upstream sites and downstream sites

in Barney Creek and Surprise Creek. This indicates electrical conductivity and sulphate concentrations have been influenced by effects other than natural causes. The most likely cause is residual impacts of historical seepage from the TSF. Similar conclusions can be drawn from time series plots (Figures 2.10 and 2.11 for electrical conductivity and sulphate concentration respectively). The impacts on sulphate concentrations and electrical conductivity appear to be equally affected in both Barney Creek and Surprise Creek. The impact on these creeks has practically immeasurable effect on electrical conductivity further downstream in the McArthur River and only a minor impact on the river's sulphate concentrations.

Application of the ANZECC methodology (median test site SW6 - does not exceed 80th percentile of reference site – SW7) indicates that the slight increase in electrical conductivity in the McArthur River downstream of the mine is of low risk for physico-chemical stressors on the aquatic ecosystem.

It should be noted that the recent installation of geopolymer barrier wall around the permitter of the TSF fronting Surprise Creek has reduced the seepage.

2.1.8 Summary of the Influence of Barney and Surprise Creeks on the McArthur River

Assessment of the spatial and temporal variability of the available water quality data by means of percentile and time-series comparison plots shows that concentrations of copper, lead and zinc in Barney Creek influence the higher concentrations in the McArthur River downstream of the mine. The Barney Creek influence is potentially partially attributable to the mining activity, however high concentrations in Barney Creek upstream of the mine indicate that natural Barney Creek flow is also a significant influence. Surprise Creek with lower filtered concentrations of copper, lead and zinc, tends to show a slight diluting effect on metals concentrations in Barney Creek before joining the main McArthur River channel downstream of the mine.

There has been an influence on electrical conductivity and sulphate concentrations in Barney and Surprise Creeks in the vicinity of the mine. However, the impacts on Barney Creek do not significantly influence electrical conductivity and sulphate concentrations in the McArthur River downstream of the mine due to substantial dilution by McArthur River flow. The slight increase in electrical conductivity in the McArthur River downstream of the mine is of low risk for physico-chemical stressors on the aquatic ecosystem.

2.2 Comparison of Bioavailable Metals Concentrations to Hardness Modified ANZECC Trigger Values

2.2.1 Hardness Modified Trigger Levels

Surface water quality monitoring data to date have not included analysis of copper, lead and zinc for evaluation of their bioavailability to aquatic ecosystems. Therefore, filtered sample concentrations of copper, lead and zinc have been considered for a conservative assessment of bioavailability on the assumption that all dissolved metals are bioavailable.

Hardness data (as mg/L $CaCO_3$) from monitoring data collected between 1995 and 2003 have been reviewed to evaluate an appropriate factor for modifying default ANZECC trigger values in accordance with ANZECC Table 3.4.3. Statistics of the hardness samples results were evaluated and a percentile curve of the three upstream sites and the McArthur River downstream site is presented in Figure 2.12. For conservatism, the median hardness from the upstream McArthur River site (SW7) of 115 mg/L was adopted for the modifier calculations. The respective default trigger values (TV) and hardness modified trigger values (HMTV) for 95% protection level of freshwater aquatic ecosystem are:

- Copper; default TV = 1.4 µg/L; HMTV = 4.4 µg/L.
- Lead; default TV = 3.4 µg/L; HMTV = 19 µg/L.
- Zinc; default TV = 8.0 µg/L; HMTV = 25 µg/L.

2.2.2 Comparison with ANZECC Hardness Modified Trigger Values

In accordance with ANZECC guidelines for toxicants, the calculated 95th percentiles of the monitoring data for each site have been compared with the respective trigger values. The comparisons are shown as plots for filtered copper (Figure 2.13), filtered lead (Figure 2.14), and filtered zinc (Figure 2.15).

The comparison shows that filtered copper, lead and zinc are well below the ANZECC hardness modified trigger values in the McArthur River (upstream and downstream of the mine). Hence bioavailable metals concentrations in the McArthur River are of low risk for toxicant concerns to the aquatic ecosystem.

Upstream sites on Barney Creek and Surprise Creek also have filtered copper and lead below the ANZECC HMTV. Zinc concentrations in upstream Surprise Creek are below the ANZECC HMTV, however upstream Barney Creek (unaffected by the mining activity) has naturally elevated zinc concentrations above the ANZECC HMTV.

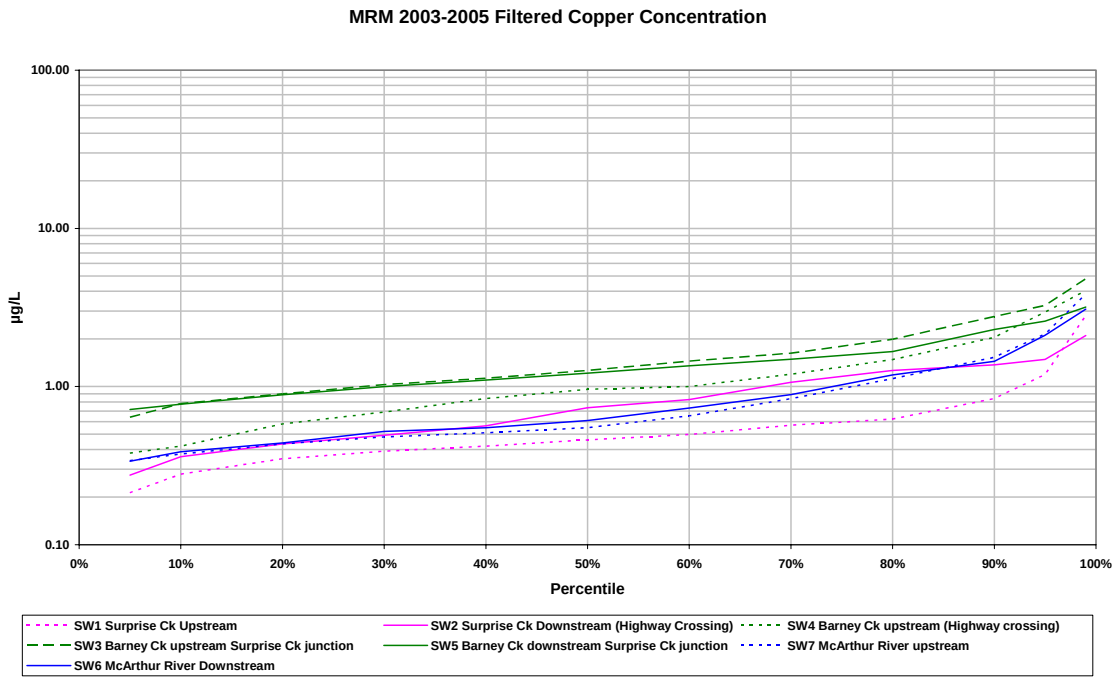


Figure 2.2 Percentiles Comparison of Filtered Copper Concentrations

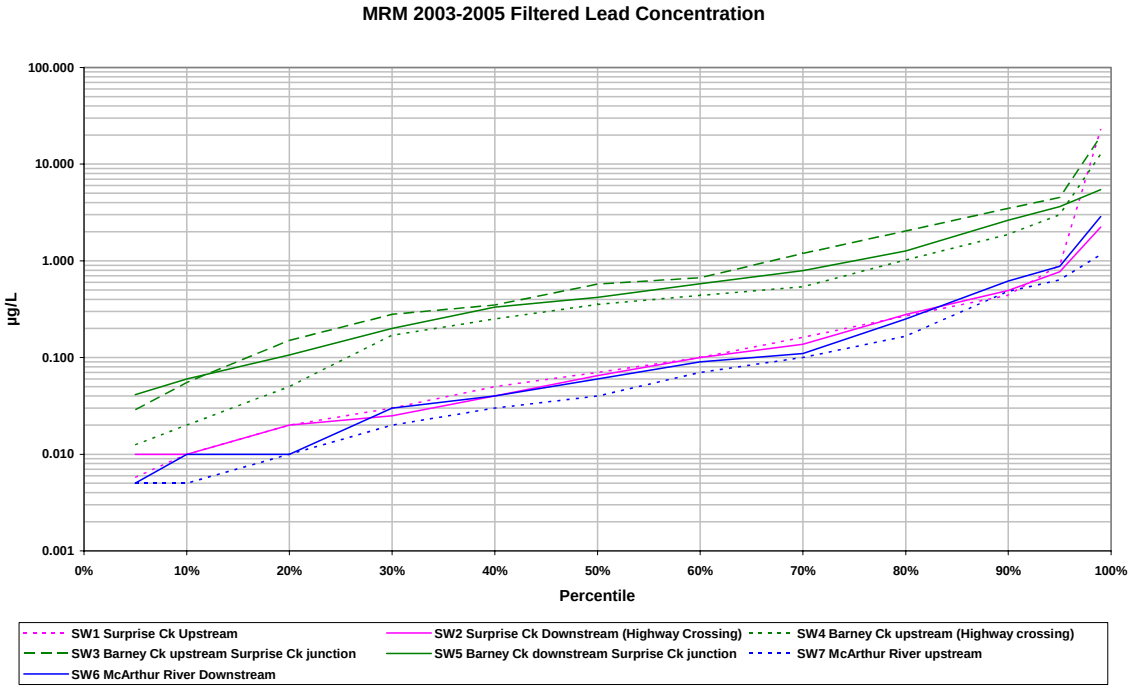


Figure 2.3 Percentiles Comparison of Filtered Lead Concentrations

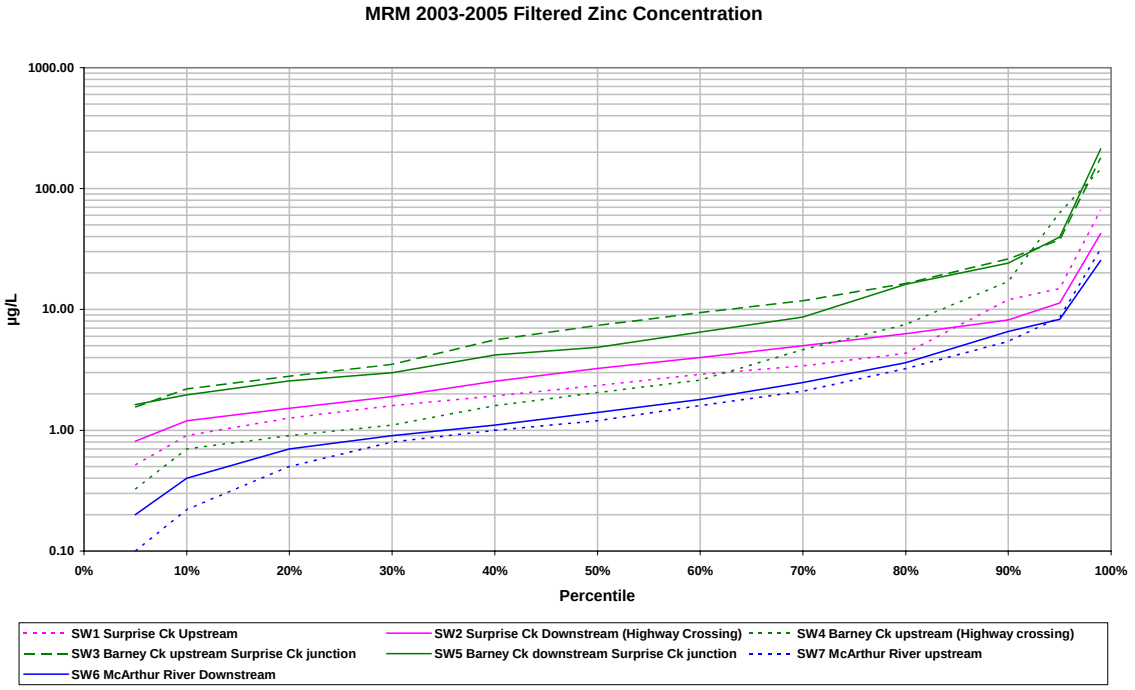


Figure 2.4 Percentiles Comparison of Filtered Zinc Concentrations

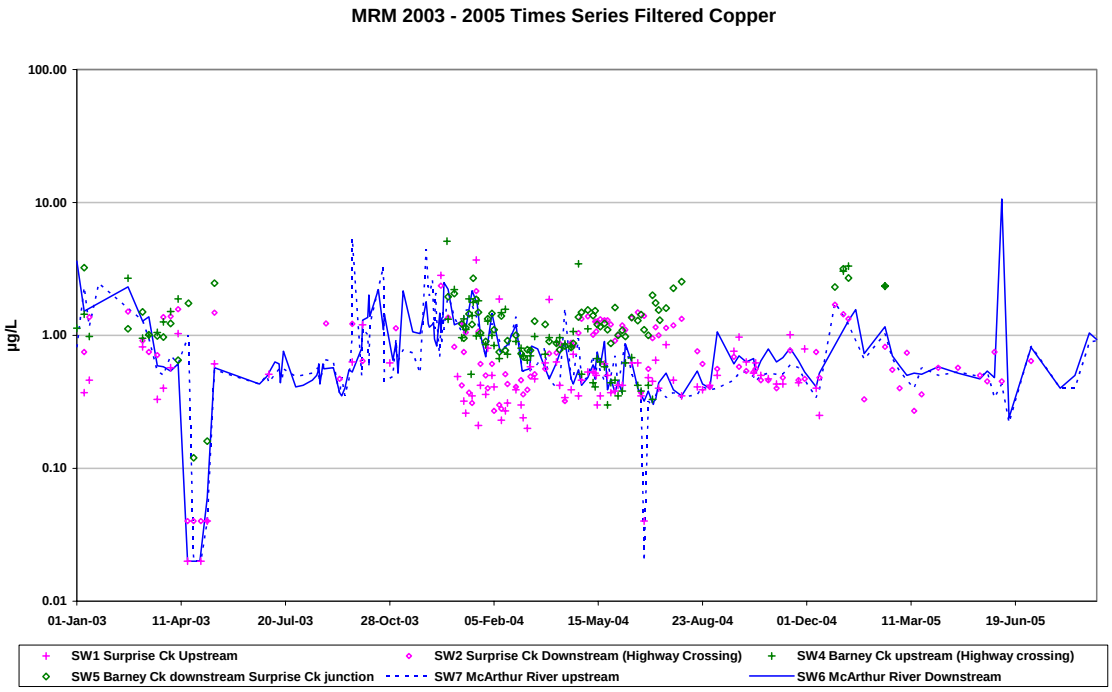


Figure 2.5 Time Series Comparison of Filtered Copper Concentrations

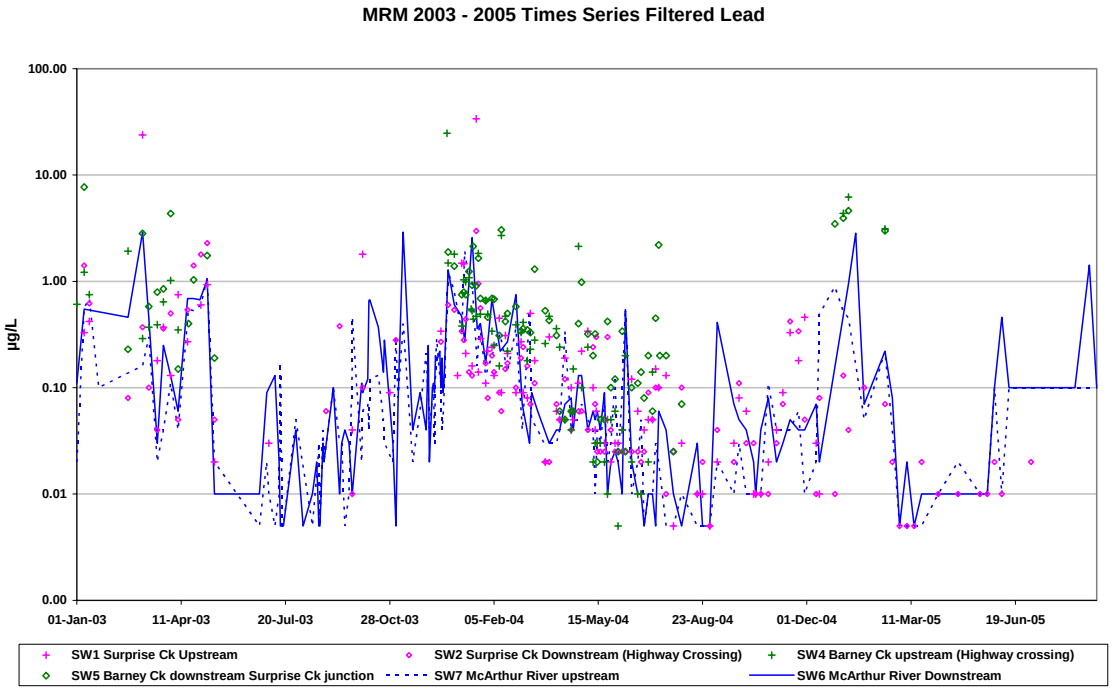


Figure 2.6 Time Series Comparison of Filtered Lead Concentrations

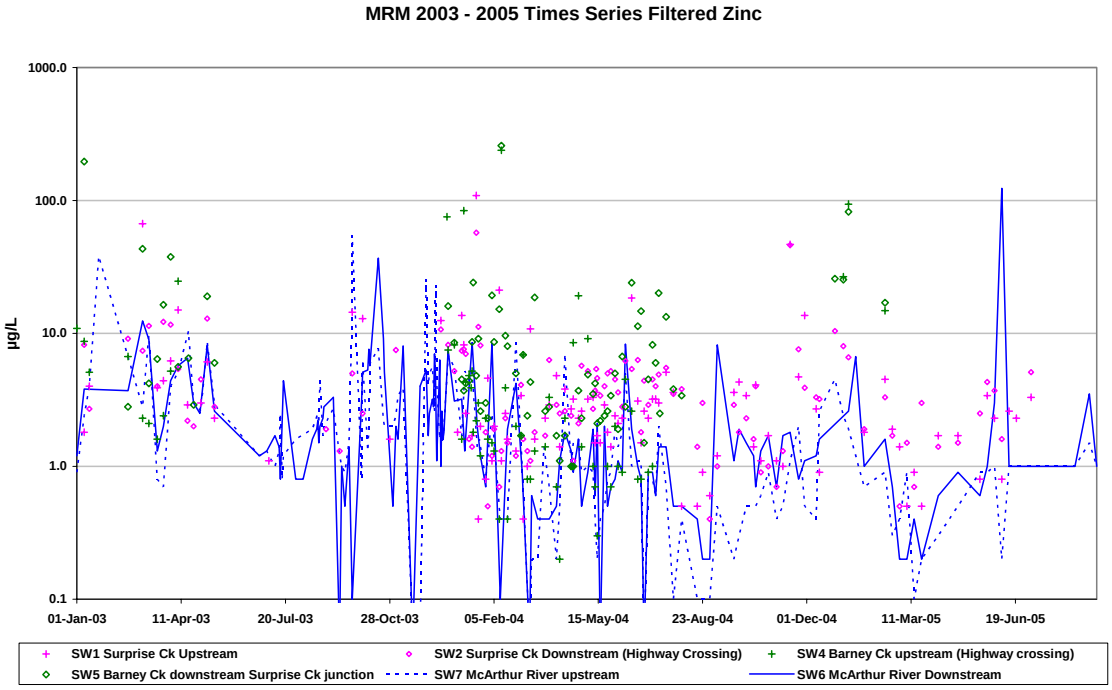


Figure 2.7 Time Series Comparison of Filtered Zinc Concentrations

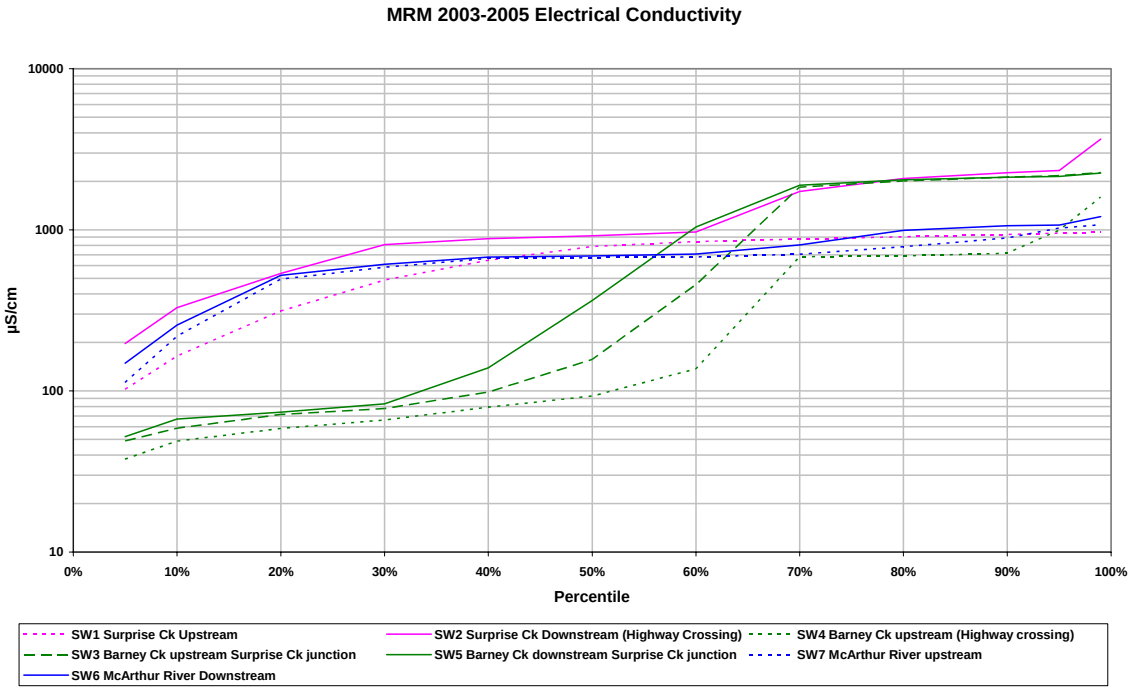


Figure 2.8 Percentiles Comparison of Electrical Conductivity

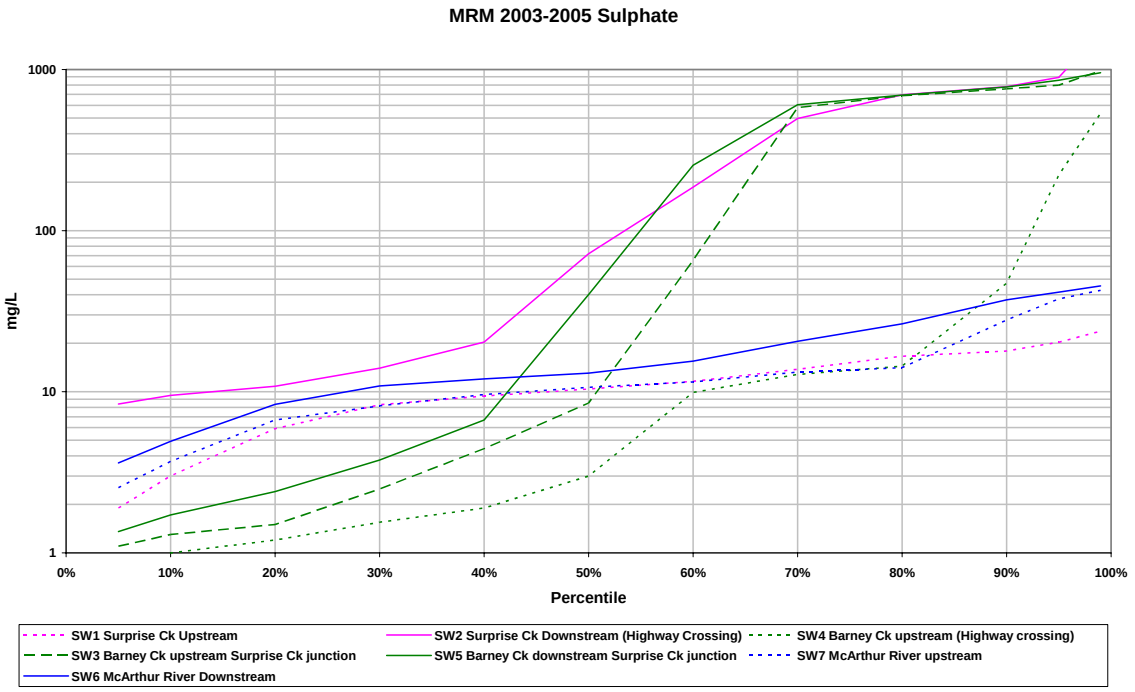


Figure 2.9 Percentiles Comparison of Sulphate Concentration

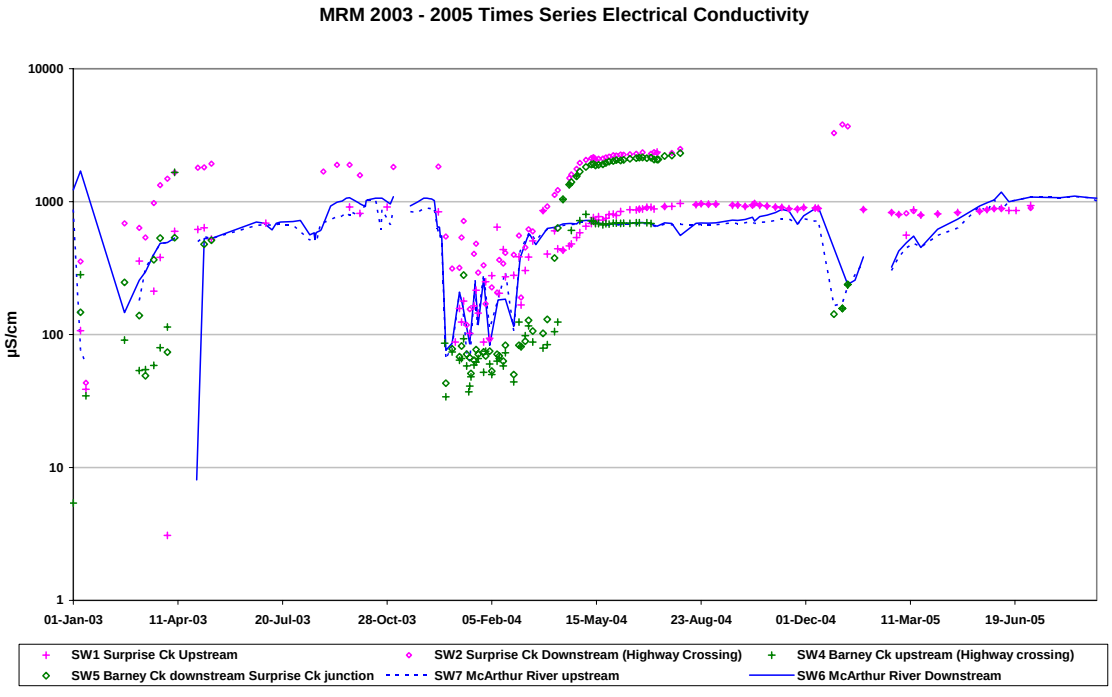


Figure 2.10 Time Series Comparison of Electrical Conductivity

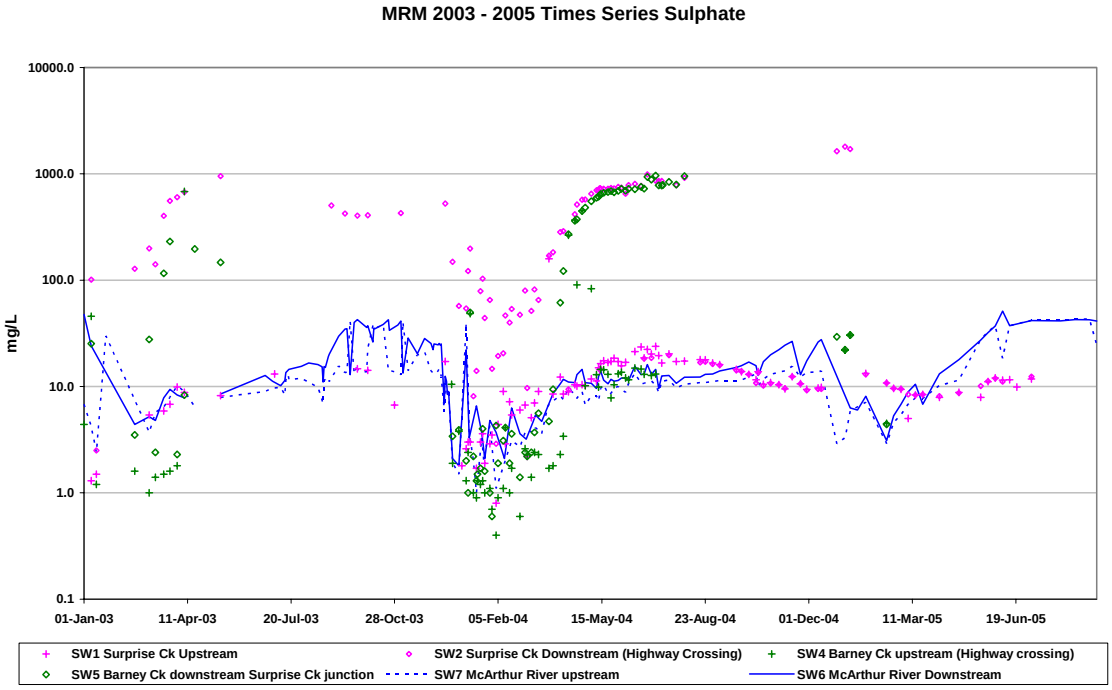


Figure 2.11 Time Series Comparison of Sulphate Concentration

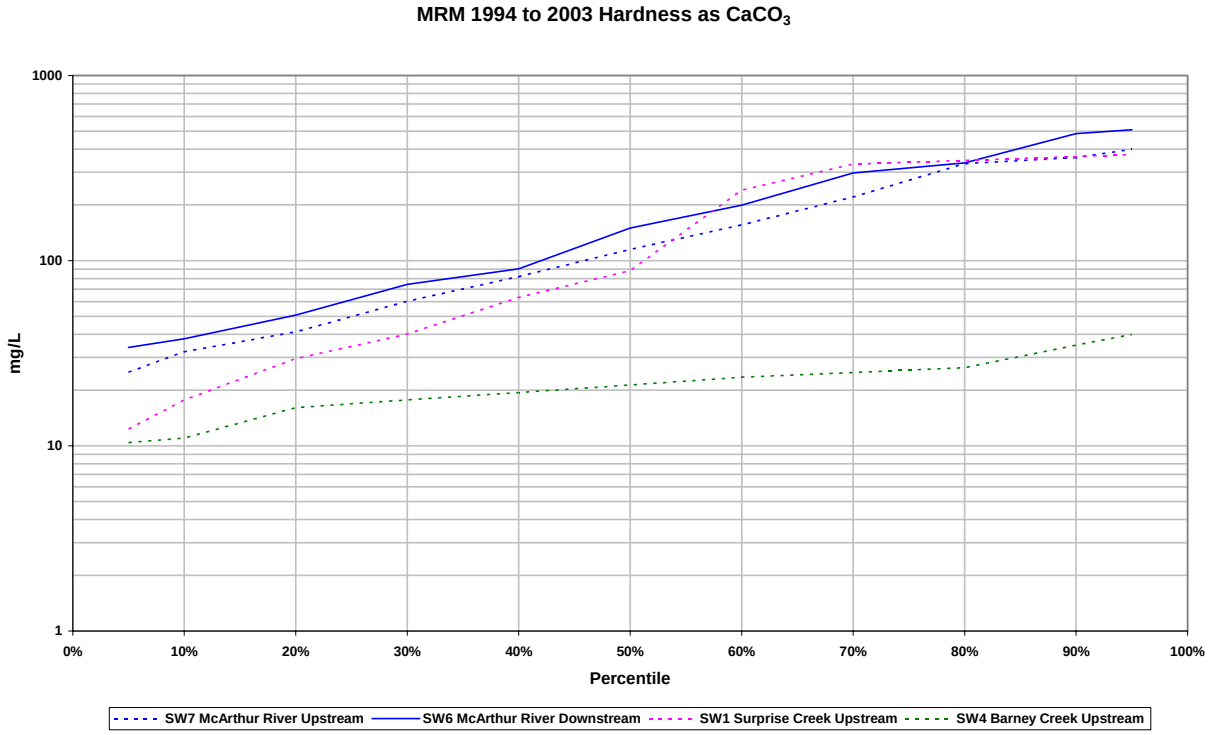
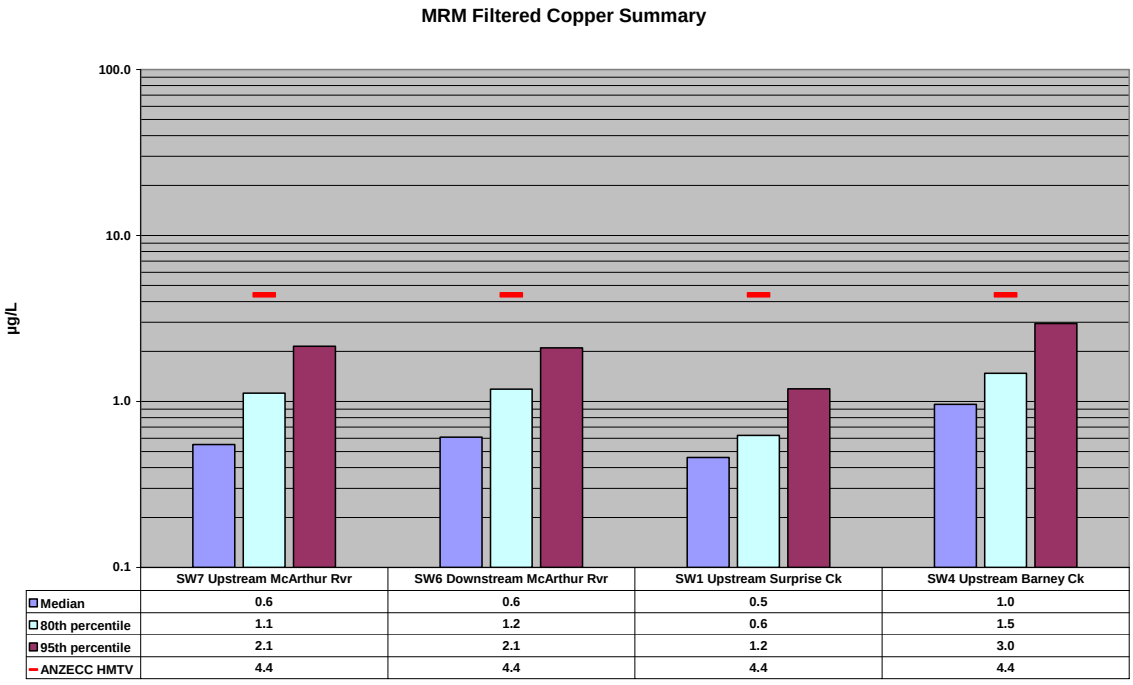
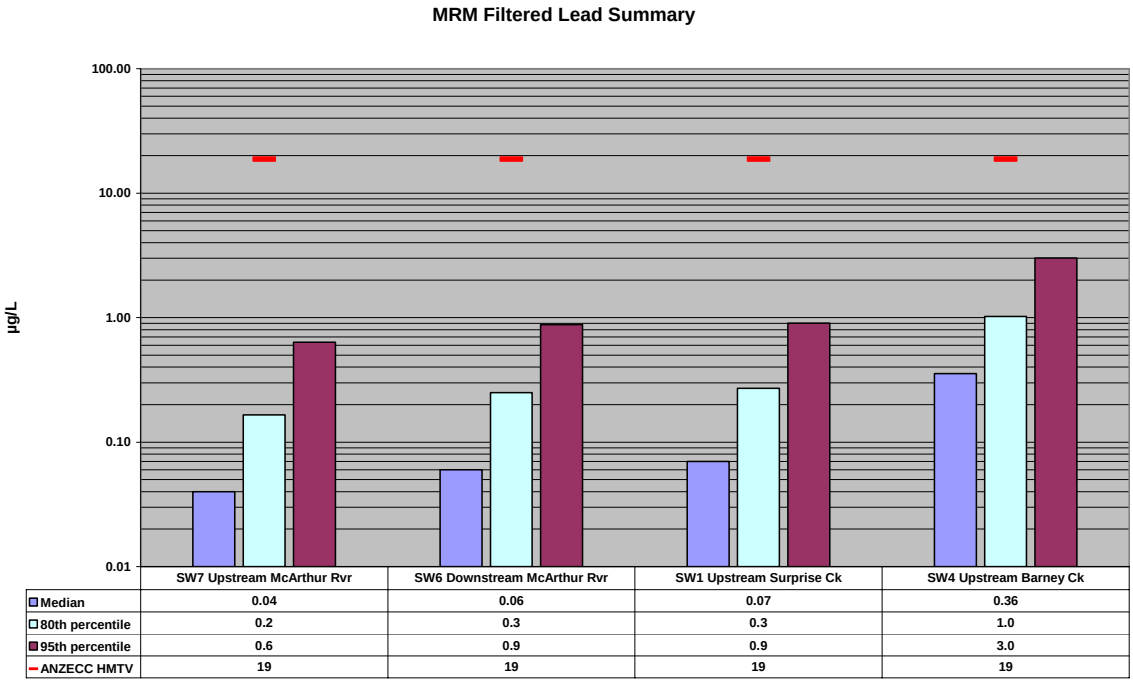


Figure 2.12 Percentiles of Water Hardness (1995 to 2003)



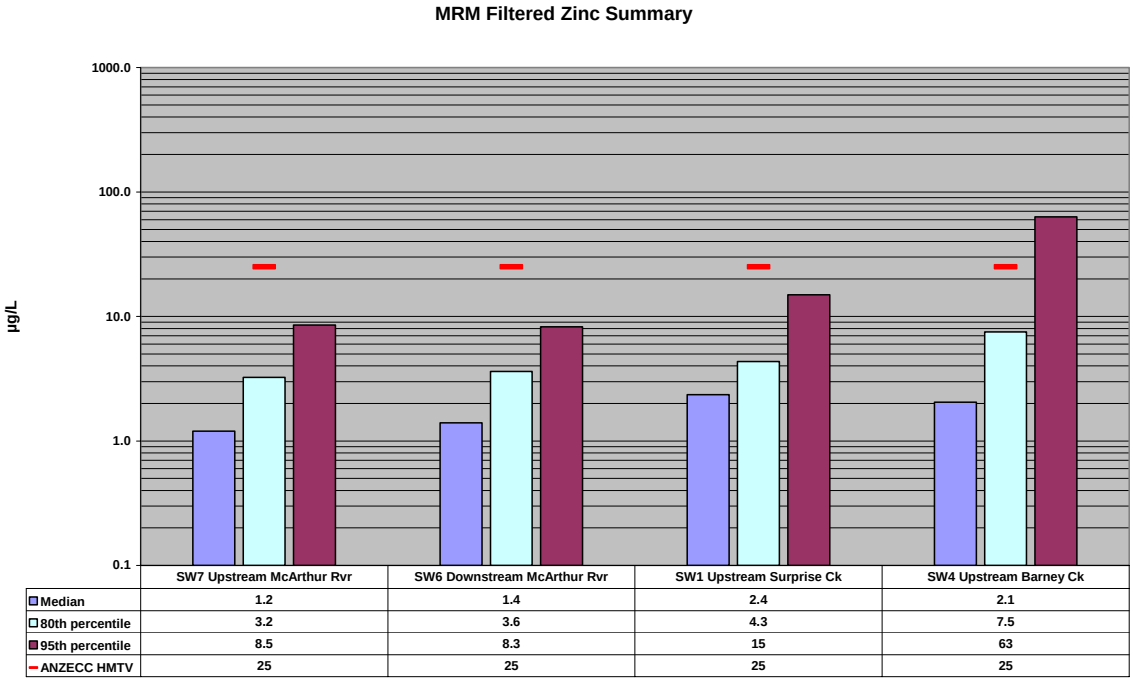
	SW7 Upstream McArthur Rvr	SW6 Downstream McArthur Rvr	SW1 Upstream Surprise Ck	SW4 Upstream Barney Ck
Median	0.6	0.6	0.5	1.0
80th percentile	1.1	1.2	0.6	1.5
95th percentile	2.1	2.1	1.2	3.0
ANZECC HMTV	4.4	4.4	4.4	4.4

Figure 2.13 Guideline Comparison of Filtered Copper Concentrations



	SW7 Upstream McArthur Rvr	SW6 Downstream McArthur Rvr	SW1 Upstream Surprise Ck	SW4 Upstream Barney Ck
Median	0.04	0.06	0.07	0.36
80th percentile	0.2	0.3	0.3	1.0
95th percentile	0.6	0.9	0.9	3.0
ANZECC HMTV	19	19	19	19

Figure 2.14 Guideline Comparison of Filtered Lead Concentrations



	SW7 Upstream McArthur Rvr	SW6 Downstream McArthur Rvr	SW1 Upstream Surprise Ck	SW4 Upstream Barney Ck
Median	1.2	1.4	2.4	2.1
80th percentile	3.2	3.6	4.3	7.5
95th percentile	8.5	8.3	15	63
ANZECC HMTV	25	25	25	25

Figure 2.15 Guideline Comparison of Filtered Zinc Concentrations