Assessment of Acid Sulfate Soil Materials (Phase 2): Edward-Wakool channel system

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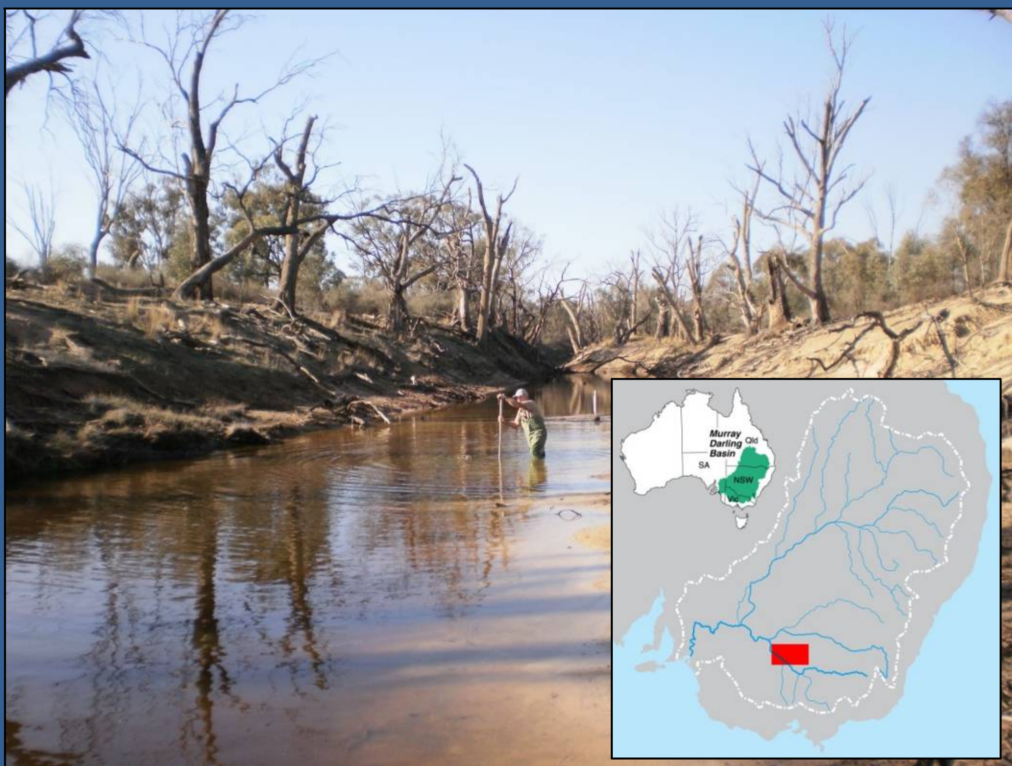
FINAL REPORT



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Cover Photograph:

Sampling in the Edward-Wakool channel system.
Photographer: Mitch Tulau.

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EXECUTIVE SUMMARY

Detailed assessments of acid sulfate soils within the Murray-Darling Basin (MDB) are conducted as a two-phase process under the MDB Acid Sulfate Soils Risk Assessment Project (ASSRAP). An initial Phase 1 acid sulfate soil investigation of the Edward-Wakool channel system in May-June 2010 showed acid sulfate soils to be a priority concern within this river and creek system (Bush *et al.* 2010). Based on Phase 1 recommendations, a Phase 2 investigation was undertaken for selected sites within the Edward-Wakool channel system to determine the nature, severity and the specific risks associated with acid sulfate soil materials. Phase 2 activities included soil laboratory analysis, a risk assessment, and interpretation and reporting, including discussion on broad acid sulfate soil management options.

The Phase 2 assessment of the Edward-Wakool channel system examined both the contaminant and metalloid dynamics and reactive metals associated with surface layers from 25 sites throughout the channel system. These results were used to determine the risks associated with contaminant mobilisation. In addition, the monosulfide formation potential test was undertaken for four surface soil materials from four channel systems including the Wakool River, Niemur River, Barbers Creek and Merran Creek. The risks associated with both acidification and de-oxygenation throughout the system were determined primarily using data from the Phase 1 assessment.

The contaminant and metalloid dynamics tests were undertaken to assess the release of metals during a water extraction, and to assess changes with time as saturated soils by incubating soil materials for periods of 1, 7, 14 and 35 days. The degree to which metal and metalloid concentrations exceed ANZECC/ARMCANZ water quality guideline values for environmental protection was used to characterise the degree of hazard. For Edward-Wakool channel system, the contaminant and metalloid dynamics test over 35 days showed that under the experimental conditions all metals and metalloids examined (with the exception of antimony (Sb) and selenium (Se)) were found to exceed the ANZECC water quality guidelines (ANZECC/ARMCANZ 2000). The guidelines for many metals were exceeded by 10 times or more, with aluminium (Al) and iron (Fe) exceeding the guidelines by more than 100 times. However, when the guideline exceedances were compared for each channel system, in the majority of channels only a few metals exceeded the guidelines by 10 times or more.

The contaminant and metalloid behaviour often varied between the metals/metalloids examined during the inundation experiments. The reductive dissolution of iron and sometimes manganese minerals seemed to have partially controlled the release of sorbed arsenic and some other metals, although the controls on release were not always clear. The trend with some metals/metalloids indicates further potential for release had the incubation experiments been allowed to proceed for a longer timeframe; it is also likely that many of the metals/metalloids will become incorporated into sulfide minerals following further reduction.

As shown in the table below, the metals/metalloids found to exceed the ANZECC water quality guidelines during the inundation experiments represent a low to high hazard. The Niemur River and Jimaringle Creek were the only two channel systems found to have a metal with a high hazard. In the majority of channels only a few metals have a moderate hazard, with three metals (i.e. chromium (Cr), iron (Fe) and silver (Ag)) identified as a hazard in all eight channel systems examined. The reactive metal concentrations were also found to be sufficiently high to be a potential hazard if released into surrounding waters. In natural systems the dynamics of metal release will be governed by the upward chemical flux, which is a function of soil type, water flow, diffusion and chemistry of the soils near the sediment-water interface (MDBA 2011).

Degree of Hazard	Guideline Threshold	Metal/Metalloid
No Hazard	Value below ANZECC guideline threshold.	Sb, Se
Low Hazard	Value exceeds ANZECC guideline threshold, but is less than 10x exceedance.	As, Cd, Ni, Zn
Moderate Hazard	Value exceeds ANZECC guideline threshold by 10x or more, but is less than 100x exceedance.	Ag, Co, Cr, Cu, Mn, Pb, V
High Hazard	Value exceeds ANZECC guideline threshold by 100x or more.	Al*, Fe

** Based on aluminium being soluble – at pH > 5.5 this is unlikely.*

Whilst the Phase 1 assessment showed the presence of monosulfidic soil materials at many sites with the Edward-Wakool channel system and often with a high de-oxygenation hazard, the monosulfide formation potential test only showed slight monosulfide formation with one of the four non-acid sulfate soil materials examined. The monosulfide formation observed represented a low de-oxygenation hazard. However, while minimal monosulfide formation was observed during the seven week inundation period, it is possible that further monosulfide formation may occur when some of the soil materials are inundated for a longer timeframe or under different geochemical conditions.

A risk assessment framework was applied to determine the specific risks associated with acidification, contaminant mobilisation and de-oxygenation (MDBA 2011). The Phase 2 assessment identified the following risks associated with the presence of acid sulfate soils in the Edward-Wakool channel system:

- high acidification risk,
- medium contaminant mobilisation risk, and
- high de-oxygenation risk.

These findings indicate that, if not managed appropriately, the acid sulfate soil materials identified in the Edward-Wakool channel system have the potential to present a serious risk to the environmental values. This report outlines the variety of management options available to manage acid sulfate soils in inland aquatic ecosystems. The most appropriate management strategy for the Edward-Wakool channel system would be to prevent oxidation of the acid sulfate soil materials identified or ensure that flow volumes are sufficient to provide adequate dilution. Neutralisation may be the best management strategy in the event of disturbance. However, in designing a management strategy for dealing with acid sulfate soils in affected inland areas, other values and uses of the channel system need to be taken into account to ensure that any intervention is compatible with other management plans and objectives.

It is important to note that the soil materials collected in May-June 2010 as part of the Phase 1 assessment only provided a snapshot of the acid sulfate soil materials present and the conditions at selected locations within the channel system. While recent disturbance and inundation may have minimised the risks identified in the short-term, it is also likely that this inundation will lead to further formation of acid sulfate soil materials.

It is recommended that, within the context of other management objectives for the channel system, consideration be given to undertaking water quality monitoring to identify potential contamination as a result of the disturbance of acid sulfate soils within the system. The presence of some high risks identified in this Phase 2 assessment indicates that senior management attention is probably needed (MDBA 2011).

1. INTRODUCTION

At its March 2008 meeting, the Murray–Darling Basin Ministerial Council discussed the emerging issue of inland acid sulfate soils and the associated risks to Murray–Darling Basin waterways and agreed that the extent of the threat posed by this issue required assessment. The purpose of the Murray–Darling Basin Acid Sulfate Soils Risk Assessment Project was to determine the spatial occurrence of, and risk posed by, acid sulfate soils at priority wetlands in the River Murray system, wetlands listed under the Ramsar Convention on Wetlands of International Importance and other key environmental sites in the Murray–Darling Basin. The project involved the selection of wetlands of environmental significance, as well as those that may pose a risk to surrounding waters. These wetlands were then subjected to a tiered assessment program, whereby wetlands were screened through a desktop assessment stage, followed by a rapid on-ground appraisal, and then detailed on-ground assessment if results of previous stages indicated an increased likelihood of occurrence of acid sulfate soils.

Detailed assessments of acid sulfate soils within the Murray-Darling Basin (MDB) are conducted as a two-phase process under the MDB Acid Sulfate Soils Risk Assessment Project (ASSRAP). Detailed Phase 1 acid sulfate soil assessments have been undertaken in both wetlands and channel systems throughout the MDB as part of the MDB ASSRAP. Phase 1 investigations are initially undertaken to determine whether acid sulfate soil materials are present (or absent) in the study area, and provide characterisation of the properties and types of acid sulfate soils. Phase 2 investigations are only conducted if the acid sulfate soil materials from Phase 1 are determined to be a priority concern for the study area and, based on Phase 1 recommendations, selected samples undergo further investigations to determine the nature, severity and the specific risks associated with the acid sulfate soil materials. Phase 2 activities include: (i) soil laboratory analysis to confirm and refine the hazards associated with contaminant mobilisation and/or deoxygenation, (ii) a risk assessment, and (iii) interpretation and reporting, including discussion on broad acid sulfate soil management options.

Detailed Phase 1 acid sulfate soil assessments were undertaken at almost 200 wetlands and river channels throughout the Murray-Darling Basin. In the Edward-Wakool channel system, a total of 60 sites throughout the region and six river reaches/pools along the main stem of the Wakool River were investigated by Southern Cross GeoScience (Bush *et al*. 2010). From these Phase 1 investigations, 25 sites from eight of the channel systems were selected for further investigation. This report outlines the results of Phase 2 activities on selected samples from the Edward-Wakool channel system (Figure 1-1).

Following the Edward-Wakool channel system Phase 1 assessment (Bush *et al.* 2010) and the priority ranking criteria adopted by the Scientific Reference Panel of the MDB ASSRAP (see Table 1-1), selected sites from within the channel system were chosen for Phase 2 detailed assessment. The Edward-Wakool channel system Phase 1 assessment identified two high priority sites based on the presence of sulfuric material, 73 high priority sites based on hypersulfidic material, seven high priority sites based on hyposulfidic ($S_{CR} \geq 0.10\%$) material and 47 high priority sites based on monosulfidic material in the Edward-Wakool channel system (Bush *et al.* 2010). There were also 11 moderate priority sites based on the presence of a hyposulfidic material with $S_{CR} < 0.10\%$. In addition, 89 of the 131 sampling sites had a high priority ranking for Phase 2 detailed assessment based on monosulfidic black ooze (MBO) formation hazard (Bush *et al.* 2010). Phase 2 investigations were carried out on 50 selected samples from high priority sites identified in the Phase 1 assessment.

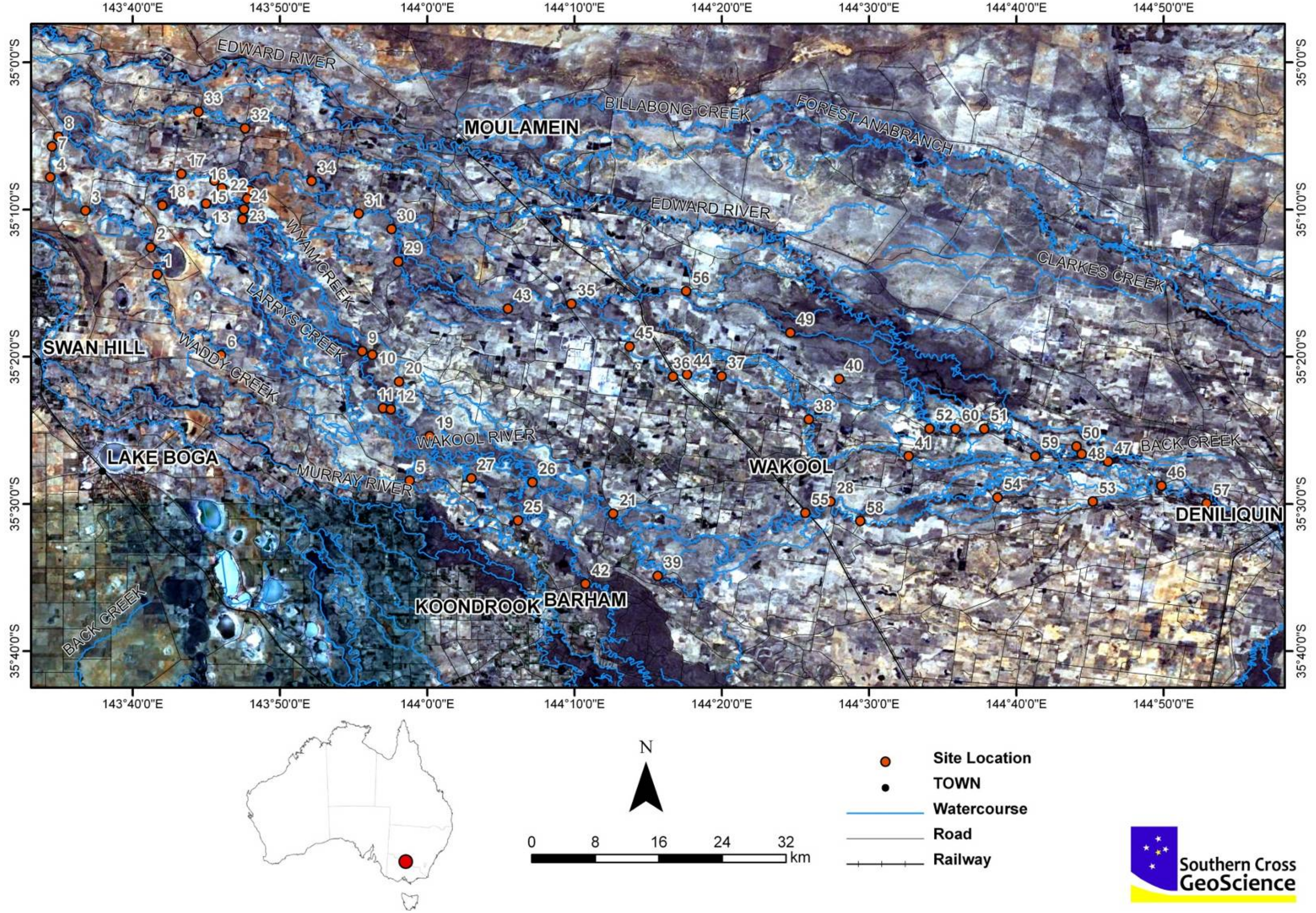

Figure 1-1: Map showing the areas assessed in the Edward-Wakool channel system (component 1) during the Phase 1 assessment.

Table 1-1. Priority ranking criteria adopted by the Scientific Reference Panel of the Murray-Darling Basin Acid Sulfate Soils Risk Assessment Project (from MDBA 2010).

Priority	Soil material
High Priority	All sulfuric materials.
	All hypersulfidic materials (as recognised by either 1) incubation of sulfidic materials or 2) a positive net acidity result with a Fineness Factor of 1.5 being used).
	All hyposulfidic materials with S_{CR} contents ≥ 0.10% S.
	All surface soil materials (i.e. within 0-20 cm) with water soluble sulfate (1:5 soil:water) contents ≥ 100 mg SO_4 kg^{-1}.
	All monosulfidic materials.
Moderate Priority	All hyposulfidic materials with S_{CR} contents < 0.10% S.
No Further Assessment	Other acidic soil materials.
	All other soil materials.

A summary of the soil laboratory analyses undertaken as part of the Phase 2 assessment and the sample selection criteria for each analysis are given in Table 1-2. Soil samples identified to undergo Phase 2 laboratory analysis are primarily from the surface layer, as this is the soil most likely to have initial contact with water. A list of the samples selected for Phase 2 analysis for the Edward-Wakool channel system is presented in Table 1-3.

Table 1-2. Rationale of sample selection for Phase 2 analysis.

Parameter	Samples selected
Contaminant and metalloid dynamics	Conducted on selected upper two surface samples
Monosulfide formation potential	Conducted on surface samples of dry sites that meet the water extractable sulfate criteria for monosulfides
Reactive metals	Conducted on selected upper two surface samples

Table 1-3. Summary of Edward-Wakool channel system samples analysed for Phase 2 assessment.

Soil Laboratory Test	Edward-Wakool Channels	[1]n
Contaminant and metalloid dynamics	**Edward-Wakool channel system (*Component 1*):** *Wakool River:* WC_13_1.1/1.2, WC_18_1.1/1.2 WC_24_1.1/1.2 *Niemur River:* WC_22_1.1/1.2, WC_31_1.1/1.2 *Jimaringle Creek:* WC_36_1.1/1.2, WC_44_1.1/1.2 *Barbers Creek:* WC_25_1.1/1.2 *Mallan Mallan Creek:* WC_15_1.1/1.2, WC_17_1.1/1.2 *Merran Creek:* WC_4_1.1/1.2, WC_6_1.1/1.2, WC_7_1.1/1.2, WC_8_1.1/1.2 *Yarrein Creek:* WC_32_1.1/1.2 *Wyam Creek:* WC_20_1.1/1.2 **Wakool River (*Component 2*):** *Wakool Weir:* S1P2_1.1/.1.2, S1P3_1.1/1.2, S1P4_1.1/1.2 *Genoe Creek:* S2P4_1.1/1.2, S2P10_1.1/1.2 *Mallan Bridge:* S3P1_1.1/1.2, S3P7_1.1/1.2 *Kyalite Boat Ramp*: S6P3_1.1/1.2, S6P6_1.1/1.2	50
Monosulfide formation potential	*Wakool River:* WC_18_.1.1 *Niemur River:* WC_31_1.1 *Barbers Creek:* WC_25_1.1 *Merran Creek:* WC_6_1.1	4
Reactive metals	Same samples as contaminant and metalloid dynamics test	50

[1]n = total number of samples analysed.
Sample numbers 1.1 and 1.2 refer to 0-5 cm and 5-10 cm soil layers, respectively.

2. LABORATORY METHODS

2.1. Laboratory analysis methods

2.1.1. Summary of laboratory methods

A list of the parameters measured and each of the method objectives for the Phase 2 assessment are summarised below in Table 2-1. All soil samples analysed in this Phase 2 assessment were collected and subsequently stored as part of the Phase 1 field assessment.

Table 2-1. Phase 2 data requirements - list of parameters and objective for conducting the test.

Parameter	Objective
Contaminant and metalloid dynamics	Assists with determining impacts on water quality by simulating time frames that create anaerobic conditions. Identifies metal release concentrations that may occur over a 5 week time frame.
Monosulfide formation potential	Determine relative propensity for monosulfides to form following inundation.
Reactive metals	Assists with determining impacts on water quality by determining weakly to moderately strongly bound metals.

Guidelines on the approaches that were followed as part of this Phase 2 assessment for the contaminant and metalloid dynamics (CMD) and monosulfide formation potential (MFP) methods are presented in full in the detailed assessment protocols (see Appendices 7 and 8, MDBA 2010). Any variations to the two methods outlined in the detailed assessment protocols are presented in Sections 2.1.2 and 2.1.3. The reactive metals method has only recently been added to the Phase 2 assessment procedure and is presented in Section 2.1.4.

2.1.2. Contaminant and metalloid dynamics method

The guidelines for the contaminant and metalloid dynamics method are outlined in Appendix 7 of the detailed assessment protocols (MDBA 2010). In this study supernatant was collected and assessed at four intervals including 24 hours, 7 days, 14 days and 35 days. The concentration of 15 metals/metalloids (i.e. aluminium (Al), antimony (Sb), arsenic (As), cadmium (Cd), chromium (Cr). cobalt (Co), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), nickel (Ni), selenium (Se), silver (Ag), vanadium (V) and zinc (Zn)) was determined by ICP-MS (Inductively Coupled Plasma - Mass Spectrometry) (APHA 2005). Redox potential (Eh) and pH were determined at each interval using calibrated electrodes linked to a TPS WP-80 meter; Eh measurements are presented versus the standard hydrogen electrode. Electrical conductivity (EC) was determined using a calibrated electrode linked to a TPS WP-81 meter. All parameters were measured on filtered (0.45 µm) water samples.

2.1.3. Monosulfide formation potential method

The guidelines for the monosulfide formation potential method are outlined in Appendix 8 of the detailed assessment protocols (MDBA 2010). In this study 3.6 g/L sucrose was used as an organic substrate instead of the 7.2 g/L outlined in the protocols. In addition to sampling after seven weeks, water samples were collected and analysed immediately after inundating the soils (i.e. Day 0). The pore-water pH and Eh were determined at Day 0.

The reactive iron (Fe) fraction in field moist sediments was extracted using 1.0 M HCl (Claff *et al.* 2010). The ferrous iron (Fe^{2+}) and total iron (Fe^{2+} + Fe^{3+}) fractions were immediately fixed following extraction. The ferrous iron trap was made up from a phenanthroline solution with an ammonium acetate buffer (APHA 2005), and the total iron trap also included a hydroxylamine solution (APHA 2005). The iron species were quantified colorimetrically using a Hach DR 2800 spectrophotometer.

Redox potential and pH were determined using calibrated electrodes linked to a TPS WP-80 meter; Eh measurements are presented versus the standard hydrogen electrode. In this study the solid phase elemental sulfur fraction was extracted using toluene as a solvent and quantified by high-performance liquid chromatography (HPLC) (McGuire and Hamers 2000). Pore-water sulfide was preserved in zinc acetate prior to determination by the spectrophotometric method of Cline (1969).

2.1.4. Reactive metals method

In this Phase 2 assessment a reactive metals method was carried out instead of the x-ray fluorescence (XRF) spectrometry method outlined in the detailed assessment protocols (MDBA 2010). While the XRF method provides data on the total elements in the soil, the reactive metals method gives an indication of the potential metal concentrations that may be released into the surrounding waters. In this method samples for analysis were prepared by disaggregation (not grinding) using a ‘jaw crusher’, and then sieved to include only the <2 mm fine earth fraction. A total of 2.5 g sediment was added to 40 mL of 0.1 M HCl, gently mixed for 1 hour and filtered through a pre-acid washed 0.45 micron nitro-cellulose filter. As with the contaminant and metalloid dynamics method, the metals were determined by ICP-MS and included aluminium (Al), antimony (Sb), arsenic (As), cadmium (Cd), chromium (Cr). cobalt (Co), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), nickel (Ni), selenium (Se), silver (Ag), vanadium (V) and zinc (Zn). The reactive metals test was conducted on all samples that underwent the contaminant and metalloid dynamics test.

2.2. Quality assurance and quality control

For all tests and analyses, the quality assurance and quality control procedures were equivalent to those endorsed by NATA (National Association of Testing Authorities). The standard procedures followed included the monitoring of blanks, duplicate analysis of at least 1 in 10 samples, and the inclusion of standards in each batch. In addition, the contaminant and metalloid dynamics tests were duplicated.

Reagent blanks and method blanks were prepared and analysed for each method. All blanks examined here were either at, or very close to, the limits of detection. On average, the frequencies of quality control samples processed were: 10% blanks, ≥ 10% laboratory duplicates, and 10% laboratory controls. The analytical precision was ±10% for all analyses.

3.RESULTS AND DISCUSSION

3.1. Summary of soil laboratory results

3.1.1. Contaminant and metalloid dynamics data

The contaminant and metalloid dynamics data for fifty Edward-Wakool channel soil materials (see Table 1-3) are presented in Appendix 1 (Tables 8-1 to 8-25) and summarised below in Table 3-1. Table 3-1 also compares the pore-water metal contents to the relevant national water quality guideline for environmental protection (ANZECC/ARMCANZ 2000).

Table 3-1. Summary of contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	Edward-Wakool channel samples		
			Min.	Median	Max.
pH		6.5-8.0	5.82	7.27	8.81
EC*	$\mu S\ cm^{-1}$	125-2,200	17	139	6,275
Eh	mV	-	-35	187	389
Ag	$\mu g\ l^{-1}$	0.05	<0.1	<0.1	1.8
Al[A]	$mg\ l^{-1}$	0.055	<0.01	0.14	34.58
As[B]	$\mu g\ l^{-1}$	13	<1.0	5.5	41.6
Cd	$\mu g\ l^{-1}$	0.2	<0.1	<0.1	1.5
Co	$\mu g\ l^{-1}$	2.8	<1.0	<1.0	44.5
Cr[C]	$\mu g\ l^{-1}$	1	<1.0	1.5	26.2
Cu[H]	$\mu g\ l^{-1}$	1.4	<1.0	1.3	79.7
Fe	$mg\ l^{-1}$	0.30	0.13	1.36	39.28
Mn	$mg\ l^{-1}$	1.70	<0.01	0.28	58.01
Ni[H]	$\mu g\ l^{-1}$	11	<1.0	1.3	19.9
Pb[H]	$\mu g\ l^{-1}$	3.4	<1.0	<1.0	71.1
Sb	$\mu g\ l^{-1}$	9	<1.0	<1.0	1.5
Se	$\mu g\ l^{-1}$	11	<1.0	<1.0	5.9
V	$\mu g\ l^{-1}$	6	<1.0	2.5	140.9
Zn[H]	$\mu g\ l^{-1}$	8	<1.0	2.4	78.0

Exceeded ANZECC Guideline (x1)	***Exceeded ANZECC Guideline (x10)***	***Exceeded ANZECC Guideline (x100)***

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with yellow, orange and red background colours.

[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

The results for all parameters measured for a selected channel system (i.e. Niemur River) are presented in Figures 3-1 to 3-4. The contaminant and metalloid dynamics data for each of the eight channel systems compared to the ANZECC water quality guidelines are also presented separately in Appendix 2 (Tables 8-37 to 8-44), and a summary of the parameters outside the guidelines is provided below in Table 3-2.

Table 3-2. Summary of parameters outside the ANZECC guidelines for each channel system.

Parameter	Wakool River	Niemur River	Jimaringle Creek	Barbers Creek	Mallan Mallan Creek	Merran Creek	Yarrein Creek	Wyam Creek
pH	✓ (x1)	✓ (x1)	✓ (x1)	×	✓ (x1)	✓ (x1)	×	✓ (x1)
EC	×	×	✓ (x1)	×	✓ (x1)	✓ (x1)	✓ (x1)	✓ (x1)
Eh	-	-	-	-	-	-	-	-
Ag	✓ (x10)	✓ (x10)	✓ (x10)	✓ (x10)	✓ (x10)	✓ (x10)	✓ (x10)	✓ (x10)
Al	✓ (x10)	✓ (x100)	×	✓ (x1)	✓ (x10)	✓ (x10)	×	×
As	✓ (x1)	✓ (x1)	✓ (x1)	✓ (x1)	✓ (x1)	✓ (x1)	×	×
Cd	×	×	×	×	×	✓ (x1)	×	×
Co	✓ (x1)	✓ (x1)	✓ (x10)	×	×	×	✓ (x1)	×
Cr	✓ (x10)	✓ (x10)	✓ (x1)	✓ (x1)	✓ (x1)	✓ (x1)	✓ (x1)	✓ (x1)
Cu	✓ (x1)	✓ (x10)	✓ (x1)	✓ (x1)	×	✓ (x1)	✓ (x1)	×
Fe	✓ (x10)	✓ (x100)	✓ (x100)	✓ (x10)	✓ (x10)	✓ (x10)	✓ (x1)	✓ (x1)
Mn	×	×	✓ (x10)	×	×	×	✓ (x1)	×
Ni	×	✓ (x1)	✓ (x1)	×	×	×	×	×
Pb	✓ (x1)	✓ (x10)	×	✓ (x1)	×	✓ (x1)	×	×
Sb	×	×	×	×	×	×	×	×
Se	×	×	×	×	×	×	×	×
V	✓ (x1)	✓ (x10)	×	×	✓ (x1)	✓ (x1)	×	×
Zn	✓ (x1)	✓ (x1)	✓ (x1)	✓ (x1)	✓ (x1)	✓ (x1)	×	×

Exceeded ANZECC Guideline (x1) (yellow) ***Exceeded ANZECC Guideline (x10)*** (orange) ***Exceeded ANZECC Guideline (x100)*** (red)

The pH for the 50 soil materials examined ranged between 5.82 and 8.81 over the 35 day timeframe of the experiment (Table 3-1). Thirteen of the soil materials had an initial pH (i.e. after 24 hours of inundation) of less than the ANZECC guideline of 6.5; nine of these soils were from the Wakool River. Soil materials from four of the channels examined (including Wakool River, Niemur River, Jimaringle Creek and Merran Creek) were less than the ANZECC guideline of 6.5 during the inundation experiments. While the pH during the inundation experiments was outside the ANZECC guidelines with many soil materials, all soil materials from Yarrein and Barbers Creeks were within the guidelines for the entire inundation period (Table 3-2). The majority of soil materials showed an increase in pH during the inundation experiments, although some of the near-neutral soil materials (i.e. pH > 7.5) showed minimal pH change or a slight pH decrease (e.g. Figure 3-1).

A decrease in Eh from oxic/suboxic to suboxic/anoxic conditions was observed with all soil materials during the inundation experiments (e.g. Figure 3-1). The data indicates that the increase in pH observed with the majority of soil materials during the inundation experiments is a consequence of reduction processes consuming acidity. Previous studies have often found inundation removes the acidity in partially-oxidised sediments as the acidity gets consumed from the reduction of iron (III) oxides, sulfates and other oxidised species by anaerobic bacteria (Dent 1986).

The electrical conductivities predominantly decreased over the timeframe of the experiment and sometimes exceeded the ANZECC guideline of 2,200 µS/cm (see Appendix 2). Samples examined from three of the channel systems (i.e. Wakool River, Niemur River and Barbers Creek) did not exceed the electrical conductivity ANZECC guideline of 2,200 µS/cm during the inundation experiments. The decrease in conductivity with time often observed would suggest the formation of insoluble mineral phases.

It is well established that inundating oxic soils can dramatically alter the mobility of metals and metalloids. Under the experimental conditions all metals and metalloids examined (with the exception of antimony (Sb) and selenium (Se)) were found to exceed the ANZECC water quality guidelines during the inundation experiments (Table 3-1). Some of the metals (i.e. aluminium (Al), chromium (Cr), copper (Cu), iron (Fe) and manganese (Mn)) were above the ANZECC guideline at all sampling intervals for some of the channel systems (see Appendix 2). The guidelines for many metals were exceeded by 10 times or more, with aluminium (Al) and iron (Fe) exceeding the guidelines by more than 100 times (Table 3-1). However, when the guideline exceedance for each metal/metalloid is examined by channel system (see Table 3-2), in the majority of channels only a few of the metals exceed the guidelines by 10 times or more. For example, only three channel systems (i.e. Wakool River, Niemur River and Jimaringle Creek) have four or more metals exceeding the guidelines by 10 times or more.

The Niemur River and Jimaringle Creek are the only channels to have a metal exeedance of 100 times or more for aluminium (Al) and/or iron (Fe) (Table 3-2). Only three metals (i.e. chromium (Cr), iron (Fe) and silver (Ag)) were found to exceed the guidelines in all eight channel systems. Sometimes elevated aluminium (Al) concentrations were observed at near neutral pH values despite aluminium (Al) having a low solubility at pH values of greater than 5.5. These elevated aluminium (Al) concentrations can be attributed a fine particle fraction which passes through the 0.45 µm filter and/or the presence of soluble aluminium (Al) complexes.

The metal/metalloid behaviour during the 35 day incubation period often varied between the metals/metalloids examined (e.g. Figures 3-2 to 3-4). The magnitude of mobilisation is affected by many factors that include but are not exclusive to: 1) the abundance and form of metal and metalloid contaminants; 2) the abundance and lability of organic matter; 3) the abundance and reactivity of iron minerals; 4) availability of sulfate; 5) acid/alkalinity buffering capacity; 6) pH; 7) EC; 8) clay content; 9) microbial activity; 10) temperature; and 11) porosity (MDBA 2010). It is expected the increase in iron (Fe) concentration that was often observed during the incubation is largely a consequence of ferric iron (Fe^{3+}) reduction releasing ferrous iron (Fe^{2+}) into solution (e.g. Figure 3-3). Many of the channel systems also showed a similar increase in manganese (Mn) suggesting reduction to a more soluble form (i.e. Mn^{2+}) (see Appendix 1). Burton *et al.* (2008) found significant mobilisation of arsenic (As) associated with ferric iron reduction following the inundation of acid sulfate soil materials, and this was also observed with many of the Edward-Wakool channel soil materials (e.g. Figure 3-2). In addition to arsenic (As), the mobilisation of some of the other metals may also be associated with the reduction of iron (Fe) (and sometimes manganese (Mn)) minerals (e.g. Figures 3-3 and 3-4).

The trend with some metals/metalloids indicates there is the potential for further release had the incubation experiments been allowed to proceed for a longer timeframe. However, it is also expected that many of the metals/metalloids will become incorporated into iron sulfide minerals (due to sorption to and/or co-precipitation) or precipitated as non-ferrous sulfides following further reduction.

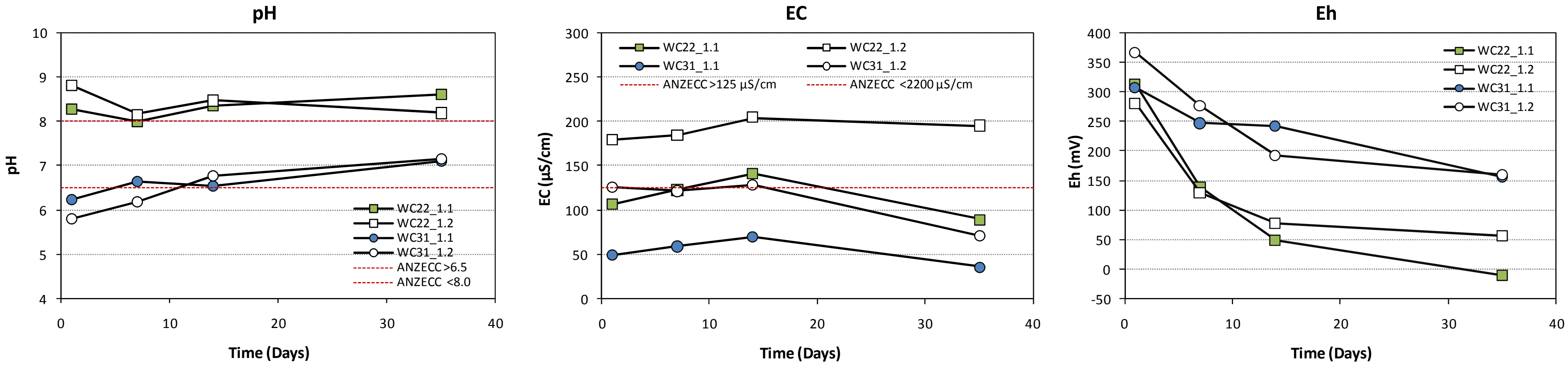

Figure 3-1: pH, EC and Eh dynamics over 35 days for the Niemur River sites (WC_22 and WC_31).

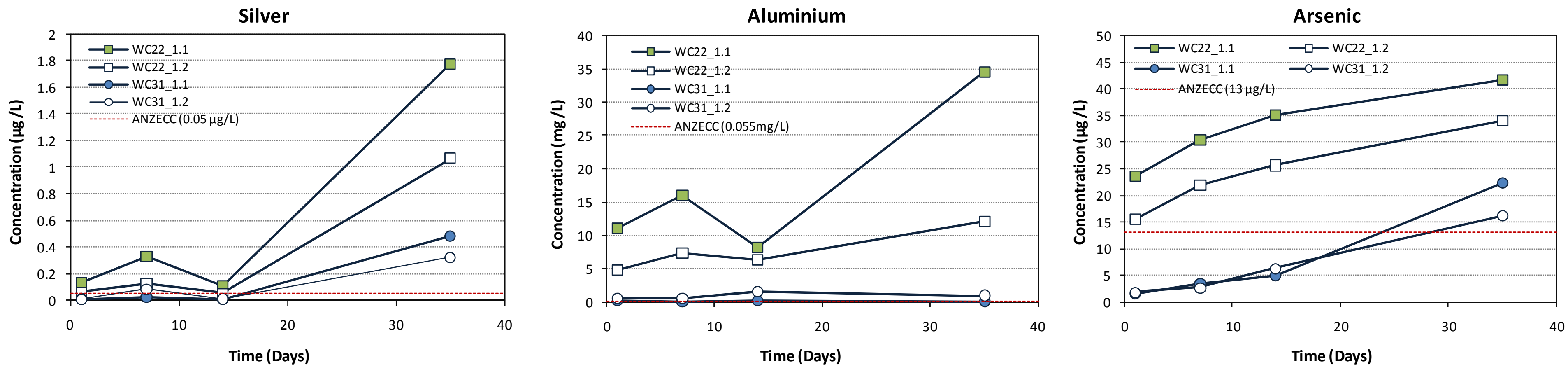

Figure 3-2: Contaminant and metalloid dynamics (Ag, Al and As) over 35 days for the Niemur River sites (WC_22 and WC_31).

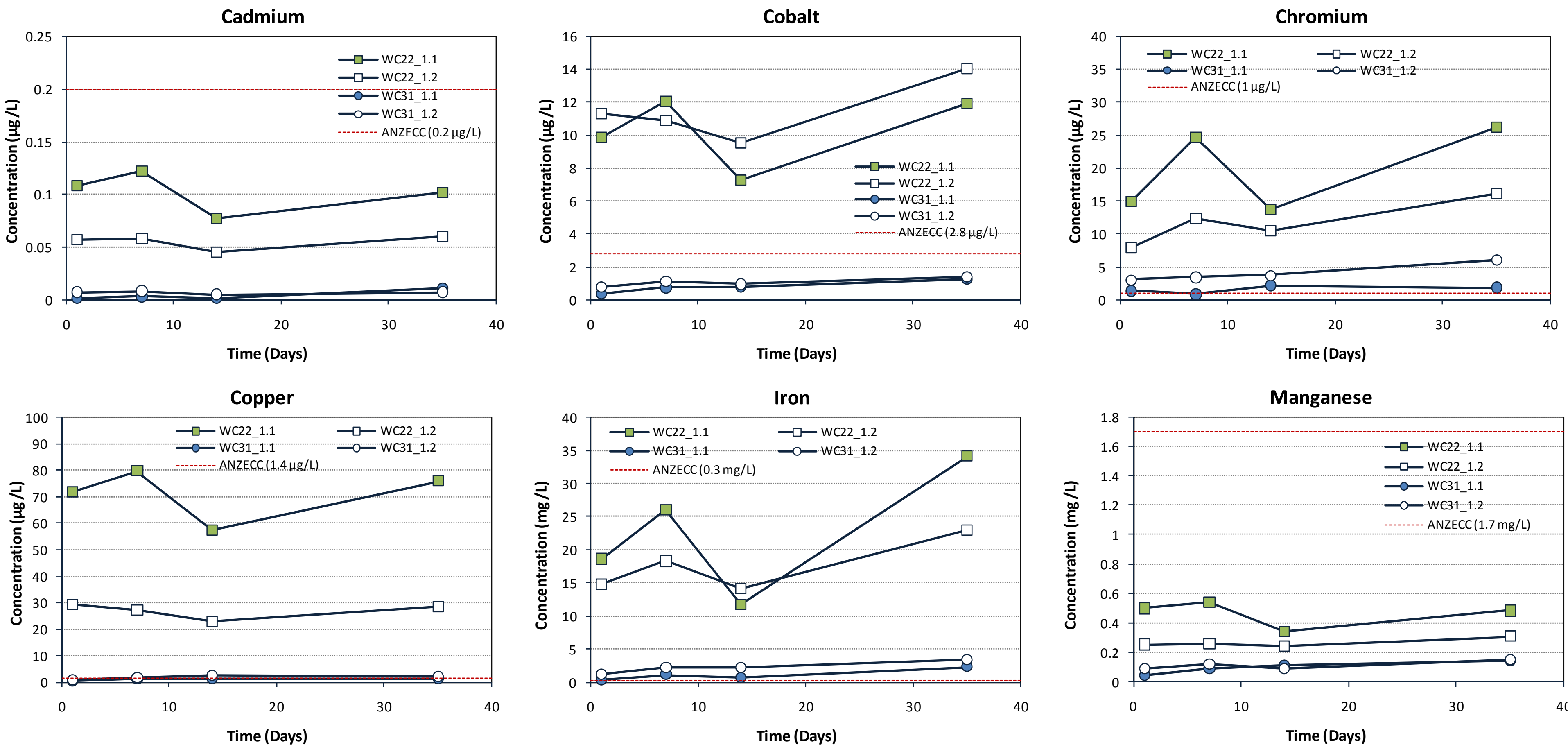

Figure 3-3: Contaminant and metalloid dynamics (Cd, Co, Cr, Cu, Fe and Mn) over 35 days for the Niemur River sites (WC_22 and WC_31).

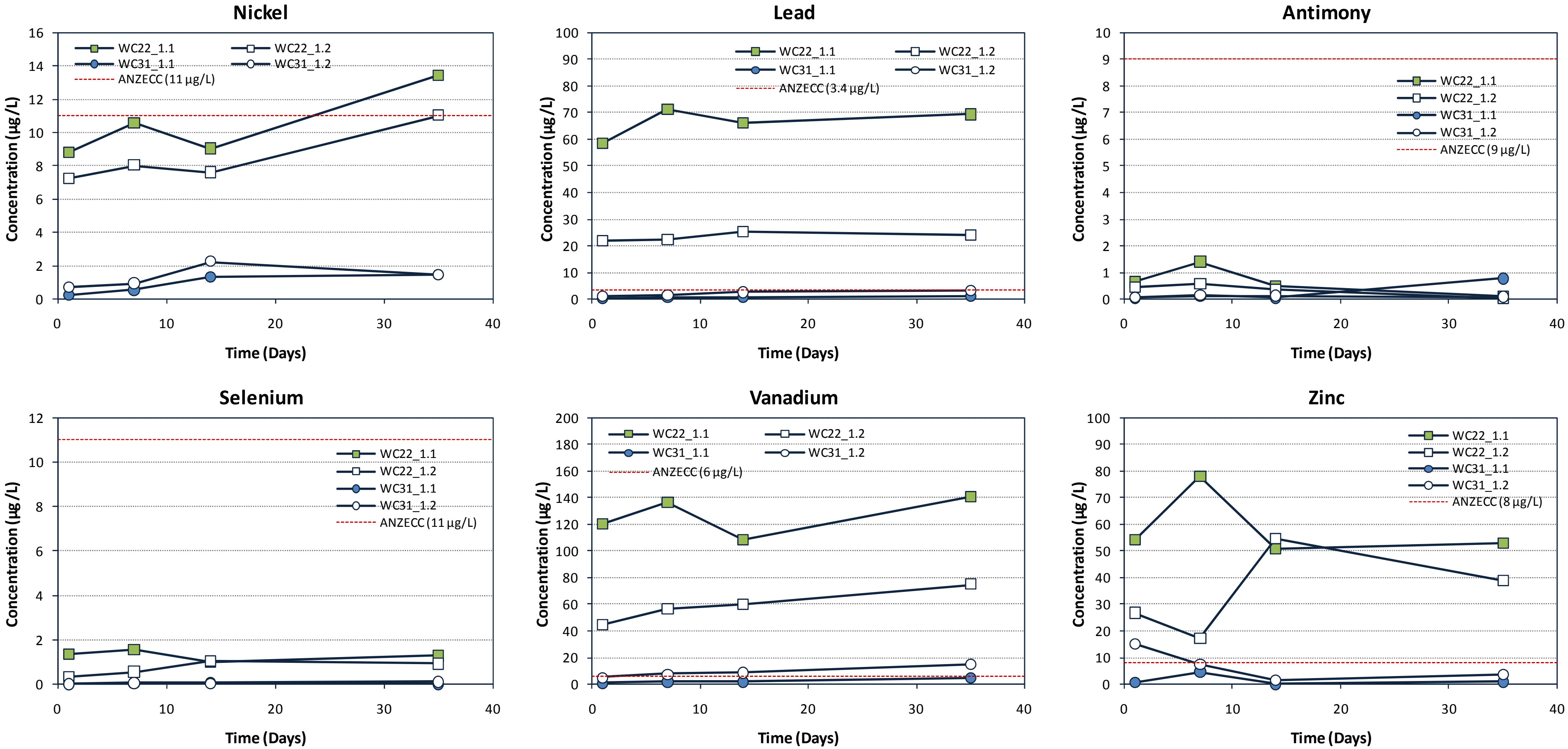

Figure 3-4: Contaminant and metalloid dynamics (Ni, Pb, Sb, Se, V and Zn) over 35 days for the Niemur River sites (WC_22 and WC_31).

3.1.2. Reactive metals data

The determination of the reactive metal fraction provides an indication of the total potential metal release from the sediment into surrounding waters. The reactive metals test used in this study gives an indication of the metals and metalloids that are more strongly bound to minerals (or weakly soluble with an acid extraction) than would be soluble with a water extraction. The moderately strong acid used (i.e. 0.1 M HCl) indicates the "stored metals" and metalloids associated with iron and manganese oxides, organic materials as well as acid soluble minerals. While the ANZECC sediment quality guidelines (ANZECC/ARMCANZ 2000) are based on total metal/metalloid concentrations, a reactive metal concentration near to or above guideline values indicate an elevated hazard.

The reactive metals data for the Edward-Wakool channel soil materials examined showed virtually all metals/metalloids were less than 40% of the ANZECC trigger value for the total metal/metalloid concentration (see Tables 8-45 to 8-53, Appendix 3). The only exception was the reactive Ni concentration at site WC_44 in the Jimaringle Creek which was 76% of the trigger value (Table 8-48, Appendix 3). The Ni concentration at this site was not observed to exceed the ANZECC water quality guidelines during the contaminant and metalloid dynamics test (Table 8-7, Appendix 1). While all reactive metal concentrations were below the ANZECC trigger value, the metal concentrations measured were sufficiently high to be a potential hazard if the total reactive fractions were to be released into a surrounding water body (i.e. above ANZECC water quality guidelines).

3.1.3. Monosulfide formation potential data

The monosulfide formation potential data following inundation for the four surface soil materials examined from the Edward-Wakool channel system are presented in Appendix 1 (Tables 8-27 and 8-28) and summarised below in Table 3-3.

Table 3-3. Summary of monosulfide formation potential data for the Edward-Wakool channel system surface soil materials following inundation.

Inundation Time	Parameter	Units	Wakool River (WC18)	Niemur River (WC31)	Barbers Creek (WC25)	Merran Creek (WC6)
Day 0	pH		6.73	i.s.	6.72	6.64
	Eh	mV	283	i.s.	345	263
Week 7	pH		3.99	4.29	4.33	4.07
	Eh	mV	312	363	345	418
	S_{AV}	Wt. %S	<0.01	<0.01	0.01	<0.01
	S^o	Wt. %S	<0.01	<0.01	<0.01	<0.01
	Pyrite-S	Wt. %S	<0.01	<0.01	<0.01	<0.01
	Dissolved S^{2-}	µg/L	<0.1	<0.1	391	0.3

i.s. Insufficient sample for analysis

The pH of the pore-waters was observed to decrease from near-neutral immediately following inundation to acidic after seven weeks of inundation (Figure 3-5). The pH of the pore-waters after seven weeks of inundation ranged between 3.99 and 4.33. The decrease in pH during the inundation experiments may be a consequence of some acidity being released from the soil materials and the pore-waters having little buffering capacity. However, it is also possible that fermentation of the organic substrate added (i.e. sucrose) may occur during inundation resulting in acidification of the pore-waters.

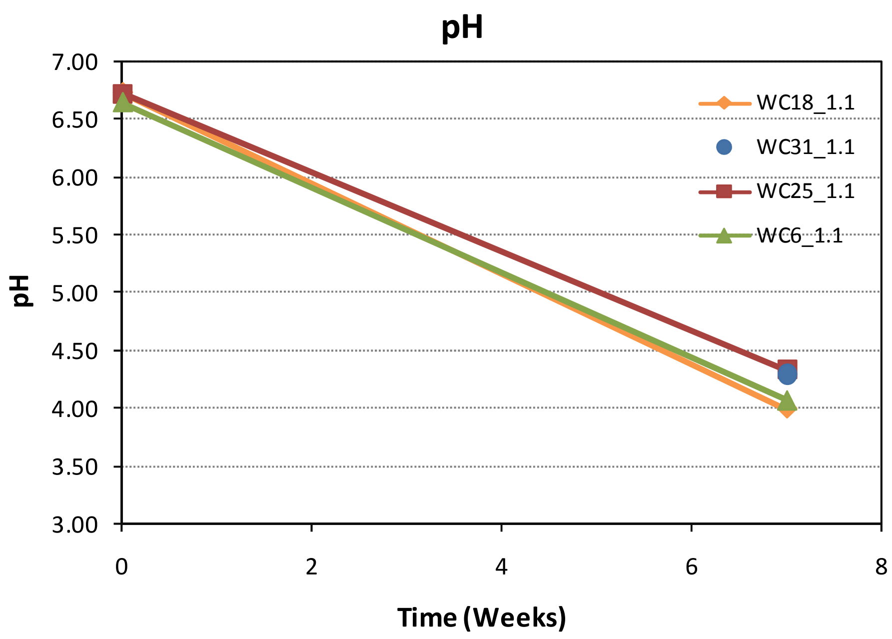

Figure 3-5: pH dynamics during inundation for the Edward-Wakool channel system soil materials.

A significant decrease in pore-water Eh was not observed during the inundation experiments with any of the soil materials (Figure 3-6), The Eh of the pore-waters after seven weeks was ≥ 312 mV indicating oxic conditions. However, a decrease in Eh to suboxic/anoxic conditions was observed with these four surface soil materials during the 35 day contaminant and metalloid dynamics experiments (see Tables 8-2, 8-5, 8-8 and 8-12, Appendix 1). The results from monosulfide formation potential experiment indicate that addition of the organic substrate exerts an effect on the reduction processes.

The four surface soil materials examined using the monosulfide formation potential test were classified as non-acid sulfate soils (Bush *et al.* 2010), and therefore did not contain any sulfides prior to inundation. While the formation of pyrite and/or elemental sulfur was not observed in any of the surface soil materials over the 7 weeks of inundation, acid volatile sulfide (S_{AV}) was detected in the Barbers Creek soil material (Table 3-3). The Barbers Creek soil material contained 0.01% S_{AV} after 7 weeks of inundation, with the remaining three soil materials having an acid volatile sulfide (S_{AV}) concentration below the limit of detection (i.e. S_{AV} < 0.01% S).

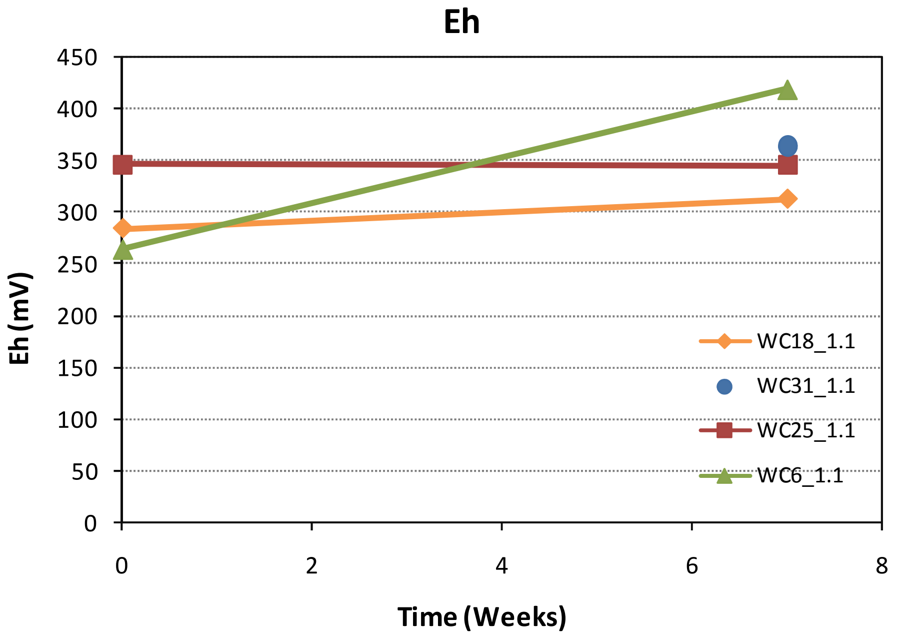

Figure 3-6: Redox potential (Eh) dynamics during inundation for the Edward-Wakool channel system soil materials.

Detectable dissolved sulfide accumulated during the inundation experiments in the pore-waters of both the Merran Creek and Barbers Creek surface soil materials with concentrations of 0.3 µg/L and 391 µg/L, respectively (Table 3-3). The redox conditions of the pore-waters suggest that the acid volatile sulfide (S_{AV}) concentration quantified in the Barbers Creek was not a iron sulfide fraction but a dissolved sulfide species (e.g. H_2S, HS^-, S^{2-} and aqueous sulfide complex). The elevated dissolved sulfide concentration in the pore-water from the Barbers Creek soil material also corresponds to the soil material with the greatest soluble sulfate concentration of 176 mg/kg (Table 3-4). Had greater reduction been observed, the iron (Fe) data indicates that iron sulfides would have formed in the soil materials examined (Table 3-4).

Table 3-4. Summary of reactive iron and water soluble sulfate data for the Edward-Wakool Channel surface soil materials.

Parameter	Units	Wakool River (WC18)	Niemur River (WC31)	Barbers Creek (WC25)	Merran Creek (WC6)
Total Fe	mg/kg	324	2,344	3,931	1,921
$Fe(II)^-$	mg/kg	76	1,327	2,057	1,074
Sulfate*	mg/kg	36.8	65.1	176	44.6

** Data from Phase 1 assessment*

3.2. Interpretation and discussion of results

This Phase 2 assessment examined the contaminant and metalloid dynamics, the reactive metals and the monosulfide formation potential of soil materials from the Edward-Wakool channel system. The contaminant and metalloid dynamics test assists in determining the impacts on water quality by simulating the release of metal and metalloid concentrations that may occur under anaerobic conditions over a several week period. The contaminant and metalloid behaviour of the soils from Edward-Wakool channel system during the 35 day inundation often varied between the metals/metalloids examined (see Figures 3-2 to 3-4). While the release of some metals/metalloids seemed to correlate with the reduction of iron (Fe) and sometimes manganese (Mn) minerals, the controls on release were not always clear. Iron (Fe) and manganese (Mn) oxides are often important sorbents for metals/metalloids, and once reduced these minerals can release the associated metals/metalloids into solution (MDBA 2011).

The contaminant and metalloid dynamics data for soils from Edward-Wakool channel system showed all metals and metalloids examined (with the exception of antimony (Sb) and selenium (Se)) were found to exceed the ANZECC water quality guidelines during the inundation experiments (Table 3-1). The guidelines for many metals were exceeded by 10 times or more, with aluminium (Al) and iron (Fe) exceeding the guidelines by more than 100 times (Table 3-1). However, when the guideline exceedance for each metal/metalloid was examined by channel system (see Table 3-2), in the majority of channels only a few of the metals exceed the guidelines by 10 times or more.

While the contaminant and metalloid dynamics test gives an indication of the metal/metalloid content of the soil, the overlying water will rarely have the concentration measured in solution during this test due to dilution in the receiving waters. It can therefore be assumed that if a metal/metalloid concentration did not exceed the ANZECC guideline during the test it does not represent an environmental hazard. Thresholds for the degree of hazard associated with the contaminant and metalloid concentrations were developed with respect to the ANZECC guidelines, and a summary of the degree of hazard that each of the metals/metalloids pose at the sites examined in the Edward-Wakool channel system is given in Table 3-2. Note the background colours presented in Tables 3-1 and 3-2 also correspond to the degree of hazard (i.e. no colour (no hazard), yellow (low hazard), orange (moderate hazard) and red (high hazard)).

The thirteen metals found to exceed the ANZECC water quality guidelines during the inundation experiments represent a low to high hazard within the Edward-Wakool channel system (Table 3-5). The Niemur River and Jimaringle Creek are the only two channel systems to have a metal with a high hazard (Table 3-6). The Niemur River had a high hazard for both aluminium (Al) and iron (Fe) whereas the Jimaringle Creek only had a high hazard for iron (Fe). When the hazard for each metal/metalloid is examined by channel system (see Table 3-6), in the majority of channels only a few of the metals have a moderate hazard. Only iron (Fe) and silver (Ag) were observed to have a moderate hazard with the majority of channel systems, and only three metals (i.e. chromium (Cr), iron (Fe) and silver (Ag)) were found to have a hazard in all eight channel systems examined.

The reactive metal concentrations were less than the ANZECC trigger value for total metals, although they were sufficiently high to be a potential hazard if released into a surrounding water body. In natural systems the dynamics of metal release will be governed by the upward chemical flux, which is a function of soil type, water flow, diffusion and chemistry of the soils near the sediment-water interface (MDBA 2011). It is also important to note that the metal/metalloid concentrations measured in this study often result from the inundation of subaqueous sulfidic soil materials. If the sulfidic soil materials were to oxidise prior to inundation it is expected that the many of the metals/metalloids would have a greater hazard due to their higher solubilities at lower pH values.

Table 3-5. Summary of the degree of hazard associated with the measured contaminant and metalloid concentrations in the Edward-Wakool channel system.

Degree of Hazard	Guideline Threshold	Metal/Metalloid
No Hazard	Value below ANZECC guideline threshold.	Sb, Se
Low Hazard	Value exceeds ANZECC guideline threshold, but is less than 10x exceedance.	As, Cd, Ni, Zn
Moderate Hazard	Value exceeds ANZECC guideline threshold by 10x or more, but is less than 100x exceedance.	Ag, Co, Cr, Cu, Mn, Pb, V
High Hazard	Value exceeds ANZECC guideline threshold by 100x or more.	Al*, Fe

** Based on aluminium (Al) being soluble – at pH > 5.5 this is unlikely.*

Table 3-6. Summary of the degree of hazard associated with the measured contaminant and metalloid concentrations in each channel system.

Channel System	Degree of Hazard			
	No Hazard	Low Hazard	Moderate Hazard	High Hazard
Wakool River	Cd, Mn, Ni, Sb, Se	As, Co, Cu, Pb, V, Zn	Ag, Al*, Cr, Fe	None
Niemur River	Cd, Mn, Sb, Se	As, Co, Ni, Zn	Ag, Cr, Cu, Pb, V	Al*, Fe
Jimaringle Creek	Al, Cd, Pb, Sb, Se, V	As, Cr, Cu, Ni, Zn	Ag, Co, Mn	Fe
Barbers Creek	Cd, Co, Mn, Ni, Sb, Se, V	Al*, As, Cr, Cu, Pb, Zn	Ag, Fe	None
Mallan Mallan Creek	Cd, Co, Cu, Mn, Ni, Pb, Sb, Se	As, Cr, V, Zn	Ag, Al*, Fe	None
Merran Creek	Co, Mn, Ni, Sb, Se	As, Cd, Cr, Cu, Pb, V, Zn	Ag, Al*, Fe	None
Yarrein Creek	Al, As, Cd, Ni, Pb, Sb, Se, V, Zn	Co, Cr, Cu, Fe, Mn	Ag	None
Wyam Creek	Al, As, Cd, Co, Cu, Mn, Ni, Pb, Sb, Se, V, Zn	Cr, Fe	Ag	None

** Based on aluminium (Al) being soluble – at pH > 5.5 this is unlikely.*

The monosulfide formation potential test assists in determining the propensity for monosulfides to form following inundation. In this study a monosulfidic soil material (i.e. $S_{AV} \geq 0.01\%$ S) was only observed to form with the Barbers Creek surface soil material (see Table 3-3). The formation of pyrite and/or elemental sulfur was not identified in any of the soil materials over the 7 week inundation period. However, sulfate reduction resulting in the formation of dissolved sulfide species was observed with the surface soil materials from Barbers Creek and Merran Creek (Table 3-3). As discussed previously, it is likely under the experimental conditions that the acid volatile sulfide (S_{AV}) fraction measured in the Barbers Creek soil material (i.e. 0.01% S_{AV}) is a dissolved sulfide species (see Section 3.1.3).

The monosulfide formation potential data indicates that the monosulfide concentration in the Barber Creek soil material represents a low de-oxygenation hazard (Table 3-7). While the other three soil materials examined represent no de-oxygenation hazard. However, while minimal monosulfide formation was observed during the seven week inundation period, it is possible that further monosulfide formation may occur when some of the soil materials are inundated for a longer timeframe or under different geochemical conditions (i.e. near neutral pH and anoxic conditions).

Table 3-7. Guideline thresholds for the degree of hazard associated with acid volatile sulfide (S_{AV}) concentrations.

Degree of Hazard	Guideline Threshold
No Hazard	< 0.01% S_{AV}
Low Hazard	0.01% S_{AV}
Moderate Hazard	0.02% S – 0.04% S_{AV}
High Hazard	≥ 0.05% S_{AV}

4. RISK ASSESSMENT

4.1. Risk assessment framework

Risk is a measure of both the consequences of a hazard occurring, and the likelihood of its occurrence (MDBA 2011). According to the National Environment Protection Measures (NEPM), risk is defined as "*the probability in a certain timeframe that an adverse outcome will occur in a person, a group of people, plants, animals and/or the ecology of a specified area that is exposed to a particular dose or concentration of a hazardous agent, i.e. it depends on both the level of toxicity of hazardous agent and the level of exposure*" (NEPC 1999).

In this study a risk assessment framework has been applied to determine the specific risks associated with acidification, contaminant mobilisation and de-oxygenation. In this risk assessment framework a series of standardised tables are used to define and assess risk (MDBA 2011). The tables determine the consequence of a hazard occurring (Table 4-1), and a likelihood rating for the disturbance scenario for each hazard (Table 4-2). These two factors are then combined in a risk assessment matrix to determine the level of risk (Table 4-3).

Table 4-1 determines the level of consequence of a hazard occurring, ranging from insignificant to extreme, and primarily takes account of the environmental and water quality impacts, to the wetland values and/or adjacent waters.

Table 4-1: Standardised table used to determine the consequences of a hazard occurring (from MDBA 2011).

Descriptor	Definition
Extreme	Irreversible damage to wetland environmental values and/or adjacent waters; localised species extinction; permanent loss of drinking water (including stock and domestic) supplies.
Major	Long-term damage to wetland environmental values and/or adjacent waters; significant impacts on listed species; significant impacts on drinking water (including stock and domestic) supplies.
Moderate	Short-term damage to wetland environmental values and/or adjacent waters; short-term impacts on species and/or drinking water (including stock and domestic) supplies.
Minor	Localised short-term damage to wetland environmental values and/or adjacent waters; temporary loss of drinking water (including stock and domestic) supplies.
Insignificant	Negligible impact on wetland environmental values and/or adjacent waters; no detectable impacts on species.

Table 4-2 determines the likelihood (i.e. probability) of disturbance for each hazard, ranging from rare to almost certain. This requires an understanding of the nature and severity of the materials (including the extent and acid generating potential of acid sulfate soil materials, and the buffering capacity of soil materials) as well as contributing factors influencing the risk (MDBA 2011). Examples of disturbance include: (i) rewetting of acid sulfate soil materials after oxidation, (ii) acid sulfate soil materials that are currently inundated and may be oxidised, or (iii) acid sulfate soil materials that are currently inundated and may be dispersed by flushing (e.g. scouring flows) (MDBA 2011). As mentioned previously, the consequence of a hazard occurring and the likelihood rating for the disturbance scenario for each hazard are then ranked using a standardised risk assessment matrix (Table 4-3).

Table 4-2: Likelihood ratings for the disturbance scenario (from MDBA 2011).

Descriptor	Definition
Almost certain	Disturbance is expected to occur in most circumstances
Likely	Disturbance will probably occur in most circumstances
Possible	Disturbance might occur at some time
Unlikely	Disturbance could occur at some time
Rare	Disturbance may occur only in exceptional circumstances

Table 4-3: Risk assessment matrix (adapted from Standards Australia & Standards New Zealand 2004).

Likelihood category	Consequences category				
	Extreme	Major	Moderate	Minor	Insignificant
Almost certain	Very high	Very high	High	Medium	Low
Likely	Very high	High	Medium	Medium	Low
Possible	High	High	Medium	Low	Low
Unlikely	High	Medium	Medium	Low	Very low
Rare	High	Medium	Low	Very low	Very low

It is suggested that:
• For *very high* risk immediate action is recommended.
• For *high* risk senior management attention is probably needed.
• Where a *medium* risk is identified management action may be recommended.
• Where the risk is *low or very low*, routine condition monitoring is suggested.

These categories of management responses have been kept quite broad to acknowledge that jurisdictional authorities and wetland managers may choose to adopt different approaches in dealing with acid sulfate soils. The imprecise nature of these management responses is intended to provide flexibility in jurisdictional and wetland manager responses to the risk ratings associated with the acid sulfate soil hazards (MDBA 2011).

4.2. Assessment of risks

The following sub-sections discuss the risks associated with acidification (Section 4.2.1), contaminant mobilisation (Section 4.2.2) and de-oxygenation (Section 4.2.3) in the Edward-Wakool channel system. The risks associated with these hazards are dependent on a variety of factors including the scenario, management regime and the species of aquatic organisms present. While likelihood of a disturbance scenario is taken into account in this risk assessment (see Table 4-2), the sensitivities and tolerances of different species of organism to each hazard has not been included. This risk assessment has primarily used the data obtained from both the Phase 1 and 2 acid sulfate soil assessments to give an overall assessment of each risk to the Edward-Wakool channel system and adjacent waters.

4.2.1. Risks associated with acidification

The Phase 1 assessment of acid sulfate soil materials in the Edward-Wakool channel system found that while low-moderate net acidities were dominant in many of the channel systems examined, several channel reaches contained hypersulfidic materials with high net acidities, indicating the acidification hazard is often high (Bush *et al.* 2010). A summary of the acidification hazards identified in each of the Edward-Wakool channel systems as part of the Phase 1 assessment is presented below in Table 4-4. The majority of channels systems were found to have a moderate-high acidification hazard (Table 4-4). In addition, the water soluble sulfate contents of surface soil materials from all channel systems except Pissen Creek were equal to or greater than the trigger value for potential monosulfidic black ooze (MBO) formation.

Table 4-4. Summary of the potential hazards posed by acid sulfate soil materials in the Edward-Wakool channel system (from Bush *et al.* 2010)

Name	Hazard Type and Class		
	Acidification	De-oxygenation	Metal mobilisation
Edward-Wakool channel system (*Component 1*):			
Wakool River	High	High	High
Niemur River – Collagen Creek	Moderate	High	High
Yallakool Creek	Low	High	Low-moderate
Jimaringle – Cockran Creek	High	High	High
Barbers Creek	Moderate	High	High
Mallan Mallan Creek	High	High	High
Merran Creek	High	High	High
Yarrein Creek	Low	High	Low-moderate
Wyam Creek	High	High	High
Pissen Creek	Low	Low	Low
Wakool River (*Component 2*):			
Wakool Weir	Moderate	High	High
Genoe Creek Junction	High	High	High
Mallan Bridge	High	High	High
Gee Gee Bridge	Low	High	Low-moderate
Yarrakool Creek Junction	Moderate	High	High
Kyalite Boat Ramp	Moderate	High	High

Sulfuric, hypersulfidic and hypermonosulfidic soil materials which all represent an acidification hazard were identified within the Edward-Wakool channel system. While sulfuric soil materials were only identified at Barbers and Wyam Creeks, 56% of sites examined contained hypersulfidic soil materials, with more than half of these sites containing hypermonosulfidic soil materials. All channels examined except Yallakool Creek, Pissen Creek and Yarrein Creek were found to contain hypersulfidic soil materials. Hypersulfidic soils with high net acidities were found in six of the channels examined including Wakool River, Jimaringle–Cockran Creek, Barbers Creek, Mallan Mallan Creek, Merran Creek and Wyam Creek. Further details on the distribution of acid sulfate soil materials in the Edward-Wakool channel system are presented in the Phase 1 assessment (Bush *et al.* 2010).

It is expected that the consequence of an acidification hazard occurring in many parts of the Edward-Wakool channel system would be *moderate* (i.e. short-term damage to environmental values and/or adjacent waters; short-term impact on species). The likelihood of these disturbance scenarios would be *almost certain*, and therefore there is a *high* risk associated with acidification in many parts of the Edward-Wakool channel system.

4.2.2. Risks associated with contaminant mobilisation

The moderate-high acidification hazard identified in the Edward-Wakool channel system Phase 1 assessment at all sites containing acid sulfate soils (except Yallakool Creek, Yarrein Creek, Pissen Creek and Gee Gee Bridge) indicated that soil acidification may increase the solubility of metals and soil acidity may be sufficient for the mobilisation of aluminium (Al) (Bush *et al.* 2010). In addition, the presence of monosulfidic materials in some surface soils and the potential for monosulfidic black ooze (MBO) formation identified at many sites may also result in an appreciable metal release hazard. The contaminant and metalloid dynamics data showed all metals and metalloids examined (with the exception of antimony (Sb) and selenium (Se)) were found to exceed the ANZECC water quality guidelines during the inundation experiments. However, when the contaminant and metalloid dynamics data was compared for each channels system (see Table 3-2) only three metals (i.e. chromium (Cr), iron (Fe) and silver (Ag)) exceed the guidelines in all channel systems.

The metal concentrations that exceeded the guidelines during the contaminant and metalloid dynamics test represented a low to high hazard, with only two metals (i.e. aluminium (Al) and iron (Fe)) having a high hazard (see Table 3-5). The metals/metalloids representing a hazard varied between the channel systems (see Table 3-6), with only two channel systems (i.e. Niemur River and Jimaringle Creek) containing metals with a high hazard. In the majority of channels examined only a few of the metals represented a moderate hazard (see Table 3-6). However, the metal/metalloid concentrations measured in this study largely result from the inundation of unoxidised subaqueous sulfidic soil materials, and therefore if these soil materials were to oxidise prior to inundation many of the metals/metalloids may pose a higher hazard due to their greater solubilities at lower pH values.

If insufficient dilution of the contaminants was to occur in the receiving waters, there is a *moderate* consequence of a contaminant mobilisation hazard occurring in all channel systems examined (i.e. short-term damage to environmental values and/or adjacent waters; short-term impact on species). This disturbance scenario would be considered *likely*, and therefore there is a *medium* risk associated with contaminant mobilisation in the Edward-Wakool channel system.

4.2.3. Risks associated with de-oxygenation

Monosulfidic soil materials pose a de-oxygenation hazard if disturbed. Whilst the monosulfide formation potential tests undertaken as part of the Phase 2 assessment only showed slight monosulfide formation within seven weeks with the Barbers Creek surface soil, the presence of monosulfidic soil materials was identified throughout the Edward-Wakool channel system during the Phase 1 assessment. The Phase 1 assessment identified the presence of monosulfidic soil materials at 36% of the sampling sites examined (Bush *et al.* 2010). Monosulfidic soil materials were observed in the surface soils (i.e. 0-10 cm) of all channels examined except Yallakool Creek, Pissen Creek, Yarrein Creek and Gee Gee Bridge. The presence of many of these monosulfidic soil materials represents a high de-oxygenation hazard. In addition, the water soluble sulfate contents of surface soil materials from all channel systems except Pissen Creek were equal to or greater than the trigger value for potential monosulfidic black ooze (MBO) formation indicating the possible development of an appreciable de-oxygenation hazard at those locations after prolonged wet conditions (see Table 4-4).

These findings therefore indicate that the de-oxygenation hazard in many parts of the Edward-Wakool channel system would represent short-term damage to environmental values and/or adjacent waters and short-term impacts on species (i.e. *moderate* consequence of a hazard occurring). Disturbance is expected to occur in most circumstances (i.e. *almost certain*) and therefore there is a *high* de-oxygenation risk in many parts of the Edward-Wakool channel system.

A summary of the risks associated with the presence of acid sulfate soils in the Edward-Wakool channel system is presented below in Table 4-5.

Table 4-5: Summary of the risks associated with acid sulfate soils in Edward-Wakool channel system.

Hazard	Level of risk
Acidification	High risk
Contaminant mobilisation	Medium risk
De-oxygenation	High risk

5. BROAD ACID SULFATE SOIL MANAGEMENT OPTIONS

This assessment identified the following risks associated with the presence of acid sulfate soils in the Edward-Wakool channel system:

- high acidification risk,
- medium contaminant mobilisation risk, and
- high de-oxygenation risk.

The acid sulfate soil materials identified in many parts of the Edward-Wakool channel system have the potential to present a serious risk to the environmental values if not managed appropriately. A variety of options are available to manage landscapes where acid sulfate soil materials are observed. A national guidance document on the management of inland acid sulfate soil landscapes titled "*National guidance for the management of acid sulfate soils in inland aquatic ecosystems"* has recently been released (EPHC & NRMMC 2011). The national guidance document provides a hierarchy of management options for managing acid sulfate soils in inland aquatic ecosystems including:

1. *Minimising the formation of acid sulfate soils in inland aquatic ecosystems.*
2. *Preventing oxidation of acid sulfate soils, if they are already present in quantities of concern or controlled oxidation to remove acid sulfate soils if levels are a concern but the water and soil has adequate neutralising capacity.*
3. *Controlling or treating acidification if oxidation of acid sulfate soils does occur.*
4. *Protecting connected aquatic ecosystems/other parts of the environment if treatment of the directly affected aquatic ecosystem is not feasible.*

In some instances it may not be practical or even sensible to undertake any active intervention (for example in a pond used as part of a salt interception scheme), in which case the management objective is:

5. *Limited further intervention.*

In designing a management strategy for dealing with acid sulfate soils in affected inland areas, other values and uses of the system need to be taken into account to ensure that any intervention is compatible with other management plans and objectives.

The possible activities associated with each management objective are summarised in Table 5-1. Further information on each management option is provided in detail in the national guidance document (EPHC & NRMMC 2011).

The presence of acid sulfate soil materials with high acidification and de-oxygenation risks and medium contaminant mobilisation risk would suggest that the most appropriate management strategy for many parts of the Edward-Wakool channel system would be to prevent oxidation of the identified acid sulfate soil materials. As outlined in Table 5-1, in order to prevent oxidation it is necessary to keep the acid sulfate soils inundated, and if possible avoid flow regimes that could re-suspend these sediments. However, if flow disturbance cannot be avoided then there is a need to ensure that the flow volumes are sufficient to provide adequate dilution to mitigate or minimise water quality impacts from acid sulfate soils. In the event of disturbance chemical ameliorants such as lime can be added to neutralise the water column and/or sediments. Details on the ameliorants available including their advantages and disadvantages are provided in the national guidance document (EPHC & NRMMC 2011). Controlled oxidation would not be a recommended management strategy in the Edward-Wakool channel system due to insufficient neutralising capacity within many of the sediments, the medium risk of contaminant release and the presence of hypermonosulfidic soil materials at the time of sampling.

Table 5-1: Summary of management options and possible activities (from EPHC & NRMMC 2011).

Management objective	Activities
Minimising the formation of acid sulfate soils in inland aquatic ecosystems	**Reduce secondary salinisation through:** • Lowering saline water tables • Maintaining the freshwater lens between saline groundwater and the aquatic ecosystem • Stopping the delivery of irrigation return water • Incorporating a more natural flow regime.
Preventing oxidation of acid sulfate soils or controlled oxidation to remove acid sulfate soils	**Preventing oxidation:** • Keep the sediments covered by water • Avoid flow regimes that could re-suspend sediments. **Controlled oxidation:** • Assess whether neutralising capacity of the sediments and water far exceeds the acidity produced by oxidation • Assess the risk of de-oxygenation and metal release. Monitor intervention and have a contingency plan to ensure avoidance of these risks.
Controlling or treating acidification	• Neutralise water column and/or sediments by adding chemical ameliorants • Add organic matter to promote bioremediation by micro-organisms • Use stored alkalinity in the ecosystem.
Protecting adjacent or downstream environments if treatment of the affected aquatic ecosystem is not feasible	• Isolate the site • Neutralise and dilute surface water • Treat discharge waters by neutralisation or biological treatment.
Limited further intervention	• Assess risk • Communicate with stakeholders • Undertake monitoring • Assess responsibilities and obligations and take action as required.

The Phase 1 acid sulfate soil assessment of the Edward-Wakool channel system (Bush *et al*. 2010) only provided a snapshot of the acid sulfate soil materials present and the conditions at selected locations within the system in May-June 2010. Since sampling the prolonged drought in the Murray-Darling Basin has come to an end and many regions including Edward-Wakool channel system have experienced major flooding. The recent floods will have scoured and oxidised the acid sulfate soil materials from the main river channels, and therefore may have minimised the risks identified in this study in the short-term. However, the recent flooding of the channels will lead to formation of acid sulfate soil materials, particularly highly reactive monosulfidic soil materials, within the Edward-Wakool channel system.

It should be noted that further understanding of the complex interactions between surface water flow, groundwater processes, biogeochemistry and the different pathways for the development of acid sulfate soils in inland aquatic ecosystems is required for satisfactory management and preventative strategies. A more robust understanding of these complex interactions is needed before implementing any new strategies for multiple benefits.

6. CONCLUSIONS AND RECOMMENDATIONS

This report provides the results of a Phase 2 investigation that was undertaken for selected locations within the Edward-Wakool channel system to determine the nature, severity and the specific risks associated with acid sulfate soil materials. The Phase 2 assessment of the Edward-Wakool channel system examined both the contaminant and metalloid dynamics and reactive metals associated with surface layers from 25 sites throughout the channel system. In addition, the monosulfide formation potential test was undertaken for four surface soil materials from four channel systems including the Wakool River, Niemur River, Barbers Creek and Merran Creek. The risks associated with both acidification and de-oxygenation throughout the system were determined primarily using data from the Phase 1 assessment (Bush *et al.* 2010).

The contaminant and metalloid dynamics over 35 days of inundation showed under the experimental conditions all metals and metalloids examined (with the exception of antimony (Sb) and selenium (Se)) were found to exceed the ANZECC water quality guidelines. The guidelines for many metals were exceeded by 10 times or more, with aluminium (Al) and iron (Fe) exceeding the guidelines by more than 100 times. However, when the guideline exceedances were compared for each channel system, in the majority of channels only a few metals exceeded the guidelines by 10 times or more.

The contaminant and metalloid behaviour often varied between the metals/metalloids examined during the inundation experiments. The reductive dissolution of iron and sometimes manganese minerals seemed to have partially controlled the release of sorbed arsenic and some other metals, although the controls on release were not always clear. The trend with some metals/metalloids indicates further potential for release had the incubation experiments been allowed to proceed for a longer timeframe; it is also likely that many of the metals/metalloids will become incorporated into sulfide minerals following further reduction.

The metals/metalloids found to exceed the ANZECC water quality guidelines during the inundation experiments represent a low to high hazard (Table 3-5). The Niemur River and Jimaringle Creek were the only two channel systems found to have a metal with a high hazard (Table 3-6). In the majority of channels only a few metals have a moderate hazard, with three metals (i.e. chromium (Cr), iron (Fe) and silver (Ag)) identified as a hazard in all eight channel systems examined. The reactive metal concentrations were also found to be sufficiently high to be a potential hazard if released into surrounding waters. In natural systems the dynamics of metal release will be governed by the upward chemical flux, which is a function of soil type, water flow, diffusion and chemistry of the soils near the sediment-water interface (MDBA 2011).

Whilst the Phase 1 assessment showed the presence of monosulfidic soil materials at many sites with the Edward-Wakool channel system and often with a high de-oxygenation hazard, the monosulfide formation potential test only showed slight monosulfide formation with one of the four non-acid sulfate soil materials examined. The monosulfide formation observed represented a low de-oxygenation hazard. However, while minimal monosulfide formation was observed during the seven week inundation period, it is possible that further monosulfide formation may occur when some of the soil materials are inundated for a longer timeframe or under different geochemical conditions.

A risk assessment framework was applied to determine the specific risks associated with acidification, contaminant mobilisation and de-oxygenation (MDBA 2011). The Phase 2 assessment identified the following risks associated with the presence of acid sulfate soils in the Edward-Wakool channel system:

- high acidification risk,

- medium contaminant mobilisation risk, and
- high de-oxygenation risk.

These findings indicate that, if not managed appropriately, the acid sulfate soil materials identified in the Edward-Wakool channel system have the potential to present a serious risk to the environmental values. This report outlines the variety of management options available to manage acid sulfate soils in inland aquatic ecosystems. The most appropriate management strategy for the Edward-Wakool channel system would be to prevent oxidation of the acid sulfate soil materials identified or ensure that flow volumes are sufficient to provide adequate dilution. Neutralisation may be the best management strategy in the event of disturbance. However, in designing a management strategy for dealing with acid sulfate soils in affected inland areas, other values and uses of the channel system need to be taken into account to ensure that any intervention is compatible with other management plans and objectives.

It is important to note that the soil materials collected in May-June 2010 as part of the Phase 1 assessment only provided a snapshot of the acid sulfate soil materials present and the conditions at selected locations within the channel system. While recent disturbance and inundation may have minimised the risks identified in the short-term, it is also likely that this inundation will lead to further formation of acid sulfate soil materials.

It is recommended that, within the context of other management objectives for the channel system, consideration be given to undertaking water quality monitoring to identify potential contamination as a result of the disturbance of acid sulfate soils within the system. The presence of some high risks identified in this Phase 2 assessment indicates that senior management attention is probably needed (MDBA 2011).

7.REFERENCES

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8. APPENDICES

APPENDIX 1. SOIL ANALYTICAL DATA

Table 8-1. Wakool River (WC_13) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_13_1.1								WC_13_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	6.92	*0.49*	8.13	*0.16*	7.49	*0.33*	8.03	*0.08*	7.25	*0.09*	7.71	*0.00*	7.59	*0.22*	7.80	*0.12*
EC*	µS cm^{-1}	125-2200	151	*113*	130	*1*	130	*21*	50	*9*	72	*2*	86	*8*	89	*6*	54	*9*
Eh	mV		331	*37*	193	*27*	67	*29*	62	*9*	316	*39*	189	*18*	74	*15*	74	*10*
Ag	µg l^{-1}	0.05	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.60	*0.55*	<0.10	*<0.10*	<0.10	*<0.10*	0.16	*0.16*	0.68	*0.64*
Al^A	mg l^{-1}	0.055	0.32	*0.02*	0.11	*<0.01*	0.22	*0.09*	0.16	*0.01*	0.36	*0.03*	0.23	*0.09*	0.24	*0.01*	0.17	*0.07*
As^B	µg l^{-1}	13	<1.0	*<1.0*	5.3	*1.3*	12.2	*4.1*	19.6	*1.2*	2.7	*<1.0*	8.5	*1.3*	10.5	*<1.0*	10.2	*3.7*
Cd	µg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	µg l^{-1}	2.8	<1.0	*<1.0*	1.6	*<1.0*	1.5	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cr^C	µg l^{-1}	1	1.8	*<1.0*	<1.0	*<1.0*	5.4	*3.6*	2.1	*<1.0*	1.7	*<1.0*	1.0	*<1.0*	1.0	*<1.0*	2.2	*<1.0*
Cu^H	µg l^{-1}	1.4	1.7	*<1.0*	1.6	*<1.0*	1.5	*<1.0*	1.2	*<1.0*	3.1	*<1.0*	3.1	*1.1*	2.5	*<1.0*	1.2	*<1.0*
Fe	mg l^{-1}	0.30	0.55	*0.06*	3.00	*0.31*	5.59	*1.37*	2.83	*0.27*	0.91	*0.21*	1.93	*0.65*	2.29	*0.14*	1.98	*0.11*
Mn	mg l^{-1}	1.70	0.08	*0.02*	0.44	*0.08*	0.73	*0.10*	0.43	*<0.01*	0.06	*<0.01*	0.13	*0.03*	0.16	*<0.01*	0.18	*0.06*
Ni^H	µg l^{-1}	11	<1.0	*<1.0*	1.3	*<1.0*	1.5	*<1.0*	<1.0	*<1.0*	2.0	*<1.0*	1.2	*<1.0*	1.5	*<1.0*	<1.0	*<1.0*
Pb^H	µg l^{-1}	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.3	*<1.0*	1.5	*<1.0*	2.1	*<1.0*	<1.0	*<1.0*
Sb	µg l^{-1}	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
V	µg l^{-1}	6	1.9	*<1.0*	2.6	*<1.0*	3.0	*<1.0*	4.5	*<1.0*	4.7	*1.5*	5.5	*1.1*	7.4	*<1.0*	5.4	*2.4*
Zn^H	µg l^{-1}	8	1.8	*<1.0*	2.5	*1.6*	23.2	*2.7*	5.4	*<1.0*	1.2	*<1.0*	3.6	*<1.0*	2.6	*2.3*	4.6	*3.9*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

Table 8-2. Wakool River (WC_18) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_18_1.1								WC_18_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	7.13	*0.04*	6.81	*0.10*	7.16	*0.21*	7.37	*0.09*	7.00	*0.04*	6.81	*0.07*	7.00	*0.20*	7.41	*0.11*
EC*	$\mu S\ cm^{-1}$	125-2200	121	*90*	34	*4*	34	*1*	20	*0*	143	*40*	171	*1*	186	*6*	104	*4*
Eh	mV		320	*27*	223	*1*	130	*19*	168	*7*	301	*2*	246	*2*	151	*20*	147	*8*
Ag	$\mu g\ l^{-1}$	0.05	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.15	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*
Al[A]	$mg\ l^{-1}$	0.055	0.40	*0.21*	0.07	*<0.01*	0.13	*0.01*	0.20	*0.03*	0.37	*0.19*	0.04	*<0.01*	0.07	*0.01*	0.05	*<0.01*
As[B]	$\mu g\ l^{-1}$	13	<1.0	*<1.0*	<1.0	*<1.0*	1.1	*<1.0*	2.5	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	2.5	*<1.0*	5.2	*1.1*
Cd	$\mu g\ l^{-1}$	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	$\mu g\ l^{-1}$	2.8	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cr[C]	$\mu g\ l^{-1}$	1	1.6	*<1.0*	<1.0	*<1.0*	3.6	*1.7*	1.1	*<1.0*	1.4	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cu[H]	$\mu g\ l^{-1}$	1.4	<1.0	*<1.0*	<1.0	*<1.0*	1.6	*<1.0*	1.6	*<1.0*	<1.0	*<1.0*	2.2	*1.7*	<1.0	*<1.0*	<1.0	*<1.0*
Fe	$mg\ l^{-1}$	0.30	0.65	*0.21*	0.32	*0.02*	0.47	*0.08*	0.70	*0.09*	0.64	*0.25*	0.23	*0.02*	0.32	*0.03*	0.49	*<0.01*
Mn	$mg\ l^{-1}$	1.70	0.11	*0.01*	0.12	*0.05*	0.19	*<0.01*	0.32	*0.04*	<0.01	*<0.01*	<0.01	*<0.01*	0.09	*<0.01*	0.15	*0.02*
Ni[H]	$\mu g\ l^{-1}$	11	<1.0	*<1.0*	<1.0	*<1.0*	2.0	*<1.0*	1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.2	*<1.0*	<1.0	*<1.0*
Pb[H]	$\mu g\ l^{-1}$	3.4	1.0	*<1.0*	<1.0	*<1.0*	1.1	*<1.0*	1.3	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.0	*<1.0*	<1.0	*<1.0*
Sb	$\mu g\ l^{-1}$	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	$\mu g\ l^{-1}$	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
V	$\mu g\ l^{-1}$	6	2.1	*<1.0*	<1.0	*<1.0*	1.5	*<1.0*	2.5	*<1.0*	3.3	*<1.0*	1.6	*<1.0*	1.3	*<1.0*	1.5	*<1.0*
Zn[H]	$\mu g\ l^{-1}$	8	1.0	*<1.0*	13.1	*9.9*	6.4	*1.2*	<1.0	*<1.0*	1.3	*<1.0*	6.4	*5.7*	8.6	*<1.0*	<1.0	*<1.0*

Notes.

The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).

** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*

Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.

[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*

[B] *Guideline assumes As in solution as Arsenic (AsV).*

[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*

[H] *Hardness affected (refer to Guidelines).*

Table 8-3. Wakool River (WC_24) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_24_1.1								WC_24_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	7.07	*0.18*	7.08	*0.17*	7.28	*0.13*	7.60	*0.12*	7.10	*0.00*	7.17	*0.09*	7.38	*0.11*	7.35	*0.13*
EC*	$\mu S\ cm^{-1}$	125-2200	873	*17*	849	*29*	882	*43*	453	*1*	774	*4*	756	*15*	788	*21*	276	*162*
Eh	mV		224	*4*	322	*37*	72	*10*	98	*27*	240	*15*	270	*20*	97	*12*	135	*4*
Ag	$\mu g\ l^{-1}$	0.05	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.76	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.36	*0.17*
Al^{A}	$mg\ l^{-1}$	0.055	0.23	*0.05*	0.18	*0.12*	0.12	*0.09*	0.11	*0.01*	0.23	*0.03*	0.22	*0.03*	0.31	*<0.01*	0.10	*0.04*
As^{B}	$\mu g\ l^{-1}$	13	1.3	*<1.0*	6.9	*2.5*	6.2	*<1.0*	9.7	*<1.0*	<1.0	*<1.0*	5.1	*<1.0*	11.0	*3.3*	20.1	*6.8*
Cd	$\mu g\ l^{-1}$	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	$\mu g\ l^{-1}$	2.8	2.3	*<1.0*	2.6	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.3	*<1.0*	1.8	*<1.0*	1.3	*<1.0*	1.2	*<1.0*
Cr^{C}	$\mu g\ l^{-1}$	1	2.0	*<1.0*	1.4	*<1.0*	2.2	*<1.0*	2.0	*<1.0*	1.6	*<1.0*	1.6	*<1.0*	2.3	*<1.0*	2.3	*<1.0*
Cu^{H}	$\mu g\ l^{-1}$	1.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.9	*<1.0*	5.2	*<1.0*	2.3	*1.3*	1.4	*<1.0*
Fe	$mg\ l^{-1}$	0.30	1.01	*0.11*	5.23	*1.69*	7.09	*2.65*	4.26	*0.88*	0.79	*0.24*	2.28	*1.12*	1.91	*0.24*	1.58	*0.05*
Mn	$mg\ l^{-1}$	1.70	0.20	*<0.01*	0.29	*0.03*	0.41	*0.04*	0.33	*0.04*	0.18	*<0.01*	0.19	*0.01*	0.20	*0.01*	0.25	*0.03*
Ni^{H}	$\mu g\ l^{-1}$	11	3.3	*<1.0*	4.4	*1.1*	3.5	*<1.0*	2.9	*<1.0*	1.7	*<1.0*	3.4	*<1.0*	3.6	*<1.0*	2.4	*<1.0*
Pb^{H}	$\mu g\ l^{-1}$	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	2.8	*<1.0*	1.3	*<1.0*	<1.0	*<1.0*
Sb	$\mu g\ l^{-1}$	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	$\mu g\ l^{-1}$	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
V	$\mu g\ l^{-1}$	6	1.7	*<1.0*	8.2	*5.8*	10.6	*<1.0*	11.5	*<1.0*	2.5	*<1.0*	5.6	*<1.0*	7.6	*1.1*	7.3	*2.6*
Zn^{H}	$\mu g\ l^{-1}$	8	1.4	*<1.0*	1.1	*<1.0*	15.5	*11.5*	2.3	*1.5*	1.7	*<1.0*	2.9	*<1.0*	19.2	*13.3*	1.9	*1.3*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

Table 8-4. Niemur River (WC_22) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_22_1.1								WC_22_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	8.29	*0.18*	8.01	*0.05*	8.36	*0.04*	8.62	*0.06*	8.81	*0.03*	8.17	*0.02*	8.47	*0.23*	8.20	*0.27*
EC*	µS cm^{-1}	125-2200	107	*4*	124	*8*	142	*10*	90	*22*	180	*0*	185	*8*	204	*13*	195	*40*
Eh	mV		314	*3*	140	*14*	49	*12*	-10	*23*	281	*8*	129	*6*	78	*2*	56	*22*
Ag	µg l^{-1}	0.05	0.13	*<0.10*	0.33	*0.22*	0.11	*<0.10*	1.77	*1.52*	<0.10	*<0.10*	0.13	*<0.10*	<0.10	*<0.10*	1.06	*0.91*
Al^{A}	mg l^{-1}	0.055	11.07	*1.29*	15.97	*0.04*	8.16	*0.67*	34.58	*16.81*	4.75	*0.21*	7.26	*0.84*	6.26	*0.64*	12.17	*3.01*
As^{B}	µg l^{-1}	13	23.7	*1.2*	30.4	*<1.0*	35.1	*<1.0*	41.6	*1.9*	15.6	*<1.0*	21.9	*1.7*	25.7	*<1.0*	34.0	*5.0*
Cd	µg l^{-1}	0.2	0.1	*<0.1*	0.1	*<0.1*	<0.1	*<0.1*	0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	µg l^{-1}	2.8	9.9	*<1.0*	12.1	*<1.0*	7.3	*<1.0*	11.9	*<1.0*	11.3	*<1.0*	10.9	*<1.0*	9.6	*<1.0*	14.0	*<1.0*
Cr^{C}	µg l^{-1}	1	14.9	*<1.0*	24.8	*1.5*	13.7	*<1.0*	26.2	*<1.0*	8.0	*<1.0*	12.4	*<1.0*	10.5	*1.8*	16.1	*1.4*
Cu^{H}	µg l^{-1}	1.4	71.8	*7.0*	79.7	*4.7*	57.3	*3.0*	75.9	*4.8*	29.5	*<1.0*	27.3	*1.4*	23.0	*<1.0*	28.8	*1.1*
Fe	mg l^{-1}	0.30	18.61	*0.86*	26.01	*1.74*	11.76	*1.27*	34.10	*10.37*	14.76	*1.83*	18.33	*0.29*	14.15	*0.31*	22.98	*4.78*
Mn	mg l^{-1}	1.70	0.50	*0.01*	0.54	*0.02*	0.35	*0.03*	0.49	*<0.01*	0.25	*<0.01*	0.26	*0.03*	0.24	*0.02*	0.31	*0.02*
Ni^{H}	µg l^{-1}	11	8.8	*<1.0*	10.6	*<1.0*	9.1	*<1.0*	13.4	*<1.0*	7.2	*<1.0*	8.0	*<1.0*	7.6	*<1.0*	11.0	*<1.0*
Pb^{H}	µg l^{-1}	3.4	58.6	*2.3*	71.1	*3.1*	66.2	*4.8*	69.3	*2.0*	21.8	*<1.0*	22.2	*2.4*	25.3	*1.6*	24.0	*<1.0*
Sb	µg l^{-1}	9	<1.0	*<1.0*	1.4	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	µg l^{-1}	11	1.4	*<1.0*	1.6	*<1.0*	1.0	*<1.0*	1.3	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.0	*<1.0*	<1.0	*<1.0*
V	µg l^{-1}	6	120.2	*5.7*	136.8	*8.1*	108.1	*6.1*	140.9	*<1.0*	44.6	*4.3*	56.5	*1.3*	59.7	*4.3*	74.7	*3.5*
Zn^{H}	µg l^{-1}	8	54.0	*6.6*	78.0	*2.1*	50.7	*2.0*	52.9	*2.5*	26.7	*1.1*	17.3	*1.4*	54.5	*12.6*	38.8	*2.2*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

Table 8-5. Niemur River (WC_31) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_31_1.1								WC_31_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	**±**	**Av.**	**±**	**Av.**	**±**	**Av.**	**±**	**Av.**	**±**	**Av.**	**±**	**Av.**	**±**	**Av.**	**±**
pH		6.5-8.0	6.25	*0.27*	6.65	*0.27*	6.54	*0.18*	7.11	*0.08*	5.82	*0.02*	6.19	*0.02*	6.78	*0.29*	7.15	*0.09*
EC*	μS cm^{-1}	125-2200	50	*7*	60	*4*	70	*10*	36	*0*	126	*7*	122	*2*	129	*8*	72	*5*
Eh	mV		308	*7*	248	*6*	242	*62*	157	*4*	367	*14*	277	*2*	192	*2*	160	*4*
Ag	μg l^{-1}	0.05	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.48	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.32	*0.17*
Al[A]	mg l^{-1}	0.055	0.21	*0.04*	0.06	*<0.01*	0.17	*0.07*	0.13	*0.03*	0.51	*0.14*	0.56	*0.11*	1.54	*0.07*	0.93	*0.17*
As[B]	μg l^{-1}	13	1.6	*<1.0*	3.5	*<1.0*	4.9	*3.9*	22.4	*3.2*	1.9	*<1.0*	2.7	*<1.0*	6.3	*3.5*	16.2	*2.1*
Cd	μg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	μg l^{-1}	2.8	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.3	*<1.0*	<1.0	*<1.0*	1.2	*<1.0*	<1.0	*<1.0*	1.4	*<1.0*
Cr[C]	μg l^{-1}	1	1.4	*<1.0*	<1.0	*<1.0*	2.2	*1.4*	1.9	*<1.0*	3.1	*<1.0*	3.5	*<1.0*	3.8	*<1.0*	6.1	*<1.0*
Cu[H]	μg l^{-1}	1.4	<1.0	*<1.0*	1.2	*<1.0*	1.2	*<1.0*	1.4	*<1.0*	<1.0	*<1.0*	1.6	*<1.0*	2.5	*<1.0*	2.2	*<1.0*
Fe	mg l^{-1}	0.30	0.33	*0.04*	1.11	*0.23*	0.62	*0.14*	2.32	*0.39*	1.30	*0.06*	2.28	*0.56*	2.25	*0.47*	3.47	*0.34*
Mn	mg l^{-1}	1.70	0.04	*<0.01*	0.09	*<0.01*	0.12	*0.05*	0.14	*0.01*	0.09	*<0.01*	0.12	*<0.01*	0.09	*<0.01*	0.15	*0.01*
Ni[H]	μg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	1.3	*<1.0*	1.4	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	2.2	*<1.0*	1.5	*<1.0*
Pb[H]	μg l^{-1}	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.2	*<1.0*	1.4	*<1.0*	2.6	*<1.0*	3.1	*<1.0*
Sb	μg l^{-1}	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	μg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
V	μg l^{-1}	6	<1.0	*<1.0*	1.9	*<1.0*	1.9	*1.1*	4.8	*<1.0*	5.1	*<1.0*	7.6	*1.6*	8.9	*3.0*	14.9	*1.8*
Zn[H]	μg l^{-1}	8	<1.0	*<1.0*	4.6	*2.8*	<1.0	-	<1.0	*<1.0*	15.1	*12.9*	7.6	*5.0*	1.4	-	3.3	-

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

Table 8-6. Jimaringle Creek (WC_36) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_36_1.1								WC_36_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	7.08	*0.02*	6.90	*0.01*	7.27	*0.07*	7.22	*0.06*	6.06	*0.01*	6.66	*0.15*	6.76	*0.20*	7.12	*0.00*
EC*	µS cm^{-1}	125-2200	2158	*196*	1959	*31*	2358	*32*	1480	*22*	2672	*392*	2520	*40*	1207	*1111*	1425	*75*
Eh	mV		333	*14*	212	*6*	92	*14*	95	*5*	356	*1*	207	*13*	117	*15*	96	*10*
Ag	µg l^{-1}	0.05	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	1.06	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.77	*0.27*
Al[A]	mg l^{-1}	0.055	<0.01	*<0.01*	0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	0.02	*0.01*	<0.01	*<0.01*	0.03	*<0.01*	<0.01	*<0.01*
As[B]	µg l^{-1}	13	<1.0	*<1.0*	4.6	*<1.0*	7.1	*<1.0*	6.9	*2.2*	<1.0	*<1.0*	1.9	*<1.0*	8.1	*<1.0*	22.4	*<1.0*
Cd	µg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	µg l^{-1}	2.8	14.4	*2.1*	30.4	*3.3*	18.5	*<1.0*	16.5	*6.5*	2.3	*<1.0*	44.5	*4.9*	43.3	*<1.0*	11.3	*4.1*
Cr[C]	µg l^{-1}	1	1.7	*<1.0*	1.0	*<1.0*	1.5	*<1.0*	1.3	*<1.0*	1.5	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.7	*<1.0*
Cu[H]	µg l^{-1}	1.4	4.4	*<1.0*	2.7	*<1.0*	2.7	*<1.0*	3.6	*<1.0*	6.5	*<1.0*	3.5	*<1.0*	3.2	*<1.0*	2.6	*<1.0*
Fe	mg l^{-1}	0.30	0.19	*0.01*	17.04	*2.04*	19.05	*1.04*	20.65	*5.68*	0.19	*0.03*	3.42	*0.76*	11.19	*2.27*	21.49	*2.35*
Mn	mg l^{-1}	1.70	5.99	*0.11*	6.93	*0.01*	9.70	*0.26*	12.91	*1.32*	2.67	*0.03*	14.19	*1.84*	9.04	*1.16*	14.24	*2.58*
Ni[H]	µg l^{-1}	11	10.1	*<1.0*	19.9	*3.1*	10.2	*<1.0*	9.2	*2.0*	8.2	*1.3*	10.7	*1.2*	16.5	*<1.0*	4.8	*<1.0*
Pb[H]	µg l^{-1}	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Sb	µg l^{-1}	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.1	*1.1*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.5	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	2.2	*<1.0*
V	µg l^{-1}	6	<1.0	*<1.0*	1.9	*<1.0*	2.8	*<1.0*	2.1	*1.0*	1.2	*<1.0*	<1.0	*<1.0*	3.1	*<1.0*	4.3	*<1.0*
Zn[H]	µg l^{-1}	8	8.0	*1.4*	5.9	*2.4*	15.0	*9.7*	4.4	*<1.0*	23.9	*4.3*	17.4	*1.3*	20.1	*16.8*	22.4	*18.7*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

Table 8-7. Jimaringle Creek (WC_44) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_44_1.1								WC_44_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	7.10	*0.14*	7.01	*0.02*	7.25	*0.01*	7.61	*0.36*	6.57	*0.01*	6.56	*0.11*	6.97	*0.04*	7.17	*0.04*
EC*	µS cm^{-1}	125-2200	4675	*25*	4815	*85*	4475	*315*	2620	*30*	4805	*45*	4885	*65*	5090	*140*	2880	*10*
Eh	mV		308	*4*	282	*29*	106	*35*	106	*17*	285	*23*	250	*2*	76	*16*	67	*9*
Ag	µg l^{-1}	0.05	0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.48	*0.17*	<0.10	*<0.10*	0.32	*0.25*	<0.10	*<0.10*	1.24	*0.83*
Al^{A}	mg l^{-1}	0.055	<0.01	*<0.01*	<0.01	*<0.01*	0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	0.02	*<0.01*	0.01	*<0.01*	<0.01	*<0.01*
As^{B}	µg l^{-1}	13	2.9	*<1.0*	4.3	*<1.0*	4.8	*<1.0*	5.3	*1.5*	1.1	*<1.0*	8.9	*1.2*	15.0	*1.9*	26.0	*<1.0*
Cd	µg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	µg l^{-1}	2.8	20.4	*<1.0*	12.6	*3.5*	9.7	*<1.0*	4.7	*2.1*	13.4	*<1.0*	19.1	*1.0*	11.9	*4.7*	2.5	*<1.0*
Cr^{C}	µg l^{-1}	1	1.6	*<1.0*	1.8	*<1.0*	1.2	*<1.0*	1.3	*<1.0*	1.6	*<1.0*	1.2	*<1.0*	1.7	*<1.0*	1.5	*<1.0*
Cu^{H}	µg l^{-1}	1.4	3.1	*<1.0*	2.3	*<1.0*	3.7	*<1.0*	4.5	*<1.0*	2.1	*<1.0*	1.9	*<1.0*	2.7	*<1.0*	2.9	*<1.0*
Fe	mg l^{-1}	0.30	0.18	*<0.01*	2.27	*0.92*	2.08	*0.59*	1.56	*0.91*	1.08	*0.13*	23.56	*2.22*	39.28	*2.70*	34.61	*6.69*
Mn	mg l^{-1}	1.70	37.95	*0.31*	55.42	*1.87*	54.07	*2.30*	58.01	*1.08*	24.03	*0.57*	27.75	*0.38*	30.52	*3.04*	29.99	*1.37*
Ni^{H}	µg l^{-1}	11	7.4	*<1.0*	5.6	*1.6*	5.0	*<1.0*	5.1	*<1.0*	1.8	*<1.0*	4.0	*<1.0*	3.6	*<1.0*	2.9	*<1.0*
Pb^{H}	µg l^{-1}	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Sb	µg l^{-1}	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.5	*1.2*	<1.0	*<1.0*	<1.0	*<1.0*
Se	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	1.0	*<1.0*	3.0	*1.3*	<1.0	*<1.0*	<1.0	*<1.0*	2.2	*<1.0*	4.3	*1.5*
V	µg l^{-1}	6	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	2.5	*<1.0*	2.7	*<1.0*
Zn^{H}	µg l^{-1}	8	7.4	*3.5*	4.2	*1.9*	5.6	*<1.0*	5.2	*<1.0*	3.6	*<1.0*	3.7	*1.3*	4.8	*2.2*	3.1	*<1.0*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

Table 8-8. Barbers Creek (WC_25) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_25_1.1								WC_25_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	7.25	*0.09*	7.28	*0.07*	7.35	*0.15*	7.65	*0.11*	7.03	*0.10*	7.14	*0.12*	7.33	*0.02*	7.42	*0.00*
EC*	μS cm^{-1}	125-2200	18	*5*	60	*0*	63	*0*	29	*3*	18	*1*	36	*2*	50	*5*	24	*3*
Eh	mV		282	*15*	209	*4*	111	*14*	91	*21*	270	*18*	202	*1*	109	*12*	115	*11*
Ag	μg l^{-1}	0.05	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.49	*0.45*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.54	*0.51*
Al^{A}	mg l^{-1}	0.055	0.19	*<0.01*	0.09	*0.01*	0.17	*0.02*	0.19	*0.02*	0.23	*0.01*	0.17	*0.03*	0.24	*0.06*	0.15	*<0.01*
As^{B}	μg l^{-1}	13	1.4	*<1.0*	5.2	*<1.0*	22.2	*1.6*	25.9	*<1.0*	2.4	*<1.0*	5.7	*1.7*	19.5	*3.5*	28.9	*<1.0*
Cd	μg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	μg l^{-1}	2.8	<1.0	*<1.0*	1.3	*<1.0*	1.2	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cr^{C}	μg l^{-1}	1	1.4	*<1.0*	<1.0	*<1.0*	1.4	*<1.0*	1.6	*<1.0*	1.6	*<1.0*	1.1	*<1.0*	1.9	*<1.0*	2.2	*<1.0*
Cu^{H}	μg l^{-1}	1.4	1.4	*<1.0*	2.0	*<1.0*	2.7	*<1.0*	1.6	*<1.0*	2.0	*<1.0*	4.4	*<1.0*	4.9	*<1.0*	2.9	*<1.0*
Fe	mg l^{-1}	0.30	0.51	*0.07*	1.52	*0.39*	5.54	*0.49*	2.33	*0.10*	0.89	*<0.01*	2.28	*0.62*	4.73	*<0.01*	2.57	*0.42*
Mn	mg l^{-1}	1.70	0.06	*0.01*	0.31	*0.01*	0.47	*0.03*	0.39	*0.04*	0.05	*<0.01*	0.19	*<0.01*	0.30	*0.02*	0.26	*0.04*
Ni^{H}	μg l^{-1}	11	<1.0	*<1.0*	1.2	*<1.0*	2.1	*<1.0*	1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	2.1	*<1.0*	<1.0	*<1.0*
Pb^{H}	μg l^{-1}	3.4	<1.0	*<1.0*	<1.0	*<1.0*	2.8	*<1.0*	1.1	*<1.0*	<1.0	*<1.0*	1.9	*<1.0*	4.2	*<1.0*	1.7	*<1.0*
Sb	μg l^{-1}	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	μg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
V	μg l^{-1}	6	1.4	*<1.0*	1.4	*<1.0*	4.3	*<1.0*	3.4	*<1.0*	2.6	*<1.0*	2.8	*<1.0*	4.9	*<1.0*	4.8	*<1.0*
Zn^{H}	μg l^{-1}	8	<1.0	*<1.0*	7.5	*6.4*	9.1	*5.7*	<1.0	*<1.0*	1.0	*<1.0*	<1.0	*<1.0*	13.9	*2.4*	3.3	*2.1*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

Table 8-9. Mallan Mallan Creek (WC_15) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_15_1.1								WC_15_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	7.96	*0.04*	7.46	*0.16*	7.71	*0.09*	8.15	*0.80*	8.35	*0.13*	7.53	*0.08*	7.90	*0.15*	8.14	*0.49*
EC*	µS cm^{-1}	125-2200	3269	*111*	3135	*375*	3205	*395*	1757	*195*	4015	*65*	3905	*85*	4170	*340*	2245	*15*
Eh	mV		319	*3*	315	*50*	78	*5*	28	*49*	303	*20*	254	*20*	30	*53*	-7	*109*
Ag	µg l^{-1}	0.05	<0.10	*<0.10*	0.11	*<0.10*	0.19	*0.16*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.30	*0.30*
Al[A]	mg l^{-1}	0.055	0.01	*<0.01*	<0.01	*<0.01*	0.11	*0.10*	0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	0.01	*<0.01*
As[B]	µg l^{-1}	13	4.5	*<1.0*	18.0	*1.3*	21.3	*2.7*	15.2	*9.7*	8.0	*2.0*	34.6	*8.3*	27.9	*4.1*	31.3	*15.9*
Cd	µg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	µg l^{-1}	2.8	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cr[C]	µg l^{-1}	1	1.9	*<1.0*	1.4	*<1.0*	1.2	*<1.0*	1.4	*<1.0*	2.0	*<1.0*	1.3	*<1.0*	1.1	*<1.0*	1.4	*<1.0*
Cu[H]	µg l^{-1}	1.4	<1.0	*<1.0*	1.0	*<1.0*	<1.0	*<1.0*	1.1	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.3	*<1.0*
Fe	mg l^{-1}	0.30	0.15	*<0.01*	1.05	*0.40*	0.66	*0.15*	1.49	*0.09*	0.14	*<0.01*	0.32	*0.15*	0.22	*0.05*	0.25	*0.13*
Mn	mg l^{-1}	1.70	0.25	*0.02*	0.62	*0.18*	1.00	*0.01*	0.95	*0.81*	0.14	*<0.01*	0.54	*0.07*	0.80	*0.08*	0.87	*0.46*
Ni[H]	µg l^{-1}	11	2.1	*<1.0*	1.9	*<1.0*	2.4	*<1.0*	1.8	*<1.0*	2.8	*<1.0*	2.1	*<1.0*	2.9	*<1.0*	2.3	*1.3*
Pb[H]	µg l^{-1}	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Sb	µg l^{-1}	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	1.2	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.2	*<1.0*	2.2	*<1.0*	4.2	*4.2*
V	µg l^{-1}	6	1.7	*<1.0*	3.3	*<1.0*	3.1	*<1.0*	4.3	*4.1*	2.6	*<1.0*	2.1	*<1.0*	4.2	*<1.0*	2.4	*2.4*
Zn[H]	µg l^{-1}	8	1.1	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.6	*<1.0*	1.3	*<1.0*	3.2	*1.9*	1.3	*<1.0*	1.5	*<1.0*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

Table 8-10. Mallan Mallan Creek (WC_17) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_17_1.1								WC_17_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	7.94	*0.14*	7.22	*0.05*	7.49	*0.04*	7.28	*0.01*	7.99	*0.09*	7.52	*0.05*	7.73	*0.02*	7.77	*0.06*
EC*	$\mu S\ cm^{-1}$	125-2200	2095	*35*	1881	*92*	2140	*29*	1141	*9*	3073	*82*	2675	*65*	2846	*13*	1628	*57*
Eh	mV		287	*23*	194	*4*	91	*1*	102	*1*	276	*3*	183	*6*	87	*22*	101	*7*
Ag	$\mu g\ l^{-1}$	0.05	0.12	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.46	*0.23*	<0.10	*<0.10*	0.24	*0.19*	<0.10	*<0.10*	0.43	*0.20*
Al^{A}	$mg\ l^{-1}$	0.055	0.57	*0.43*	0.02	*<0.01*	0.05	*0.03*	0.02	*<0.01*	0.06	*0.03*	0.01	*<0.01*	0.01	*<0.01*	0.02	*0.01*
As^{B}	$\mu g\ l^{-1}$	13	8.4	*1.8*	16.3	*<1.0*	18.1	*<1.0*	14.9	*<1.0*	2.1	*<1.0*	4.6	*<1.0*	10.2	*2.2*	10.8	*4.8*
Cd	$\mu g\ l^{-1}$	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	$\mu g\ l^{-1}$	2.8	2.3	*<1.0*	1.5	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cr^{C}	$\mu g\ l^{-1}$	1	2.7	*<1.0*	1.6	*<1.0*	1.5	*<1.0*	2.0	*<1.0*	2.3	*<1.0*	1.2	*<1.0*	1.9	*<1.0*	1.7	*<1.0*
Cu^{H}	$\mu g\ l^{-1}$	1.4	1.3	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Fe	$mg\ l^{-1}$	0.30	0.62	*0.38*	0.65	*0.21*	2.55	*0.37*	3.18	*0.13*	0.20	*0.02*	0.34	*0.09*	0.87	*0.56*	0.79	*0.12*
Mn	$mg\ l^{-1}$	1.70	0.21	*<0.01*	0.47	*0.02*	0.74	*0.01*	0.98	*0.01*	0.12	*<0.01*	0.22	*<0.01*	0.31	*0.02*	0.38	*0.01*
Ni^{H}	$\mu g\ l^{-1}$	11	4.3	*<1.0*	2.9	*<1.0*	2.8	*<1.0*	1.7	*<1.0*	1.2	*<1.0*	1.1	*<1.0*	1.5	*<1.0*	<1.0	*<1.0*
Pb^{H}	$\mu g\ l^{-1}$	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Sb	$\mu g\ l^{-1}$	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.3	*1.1*	<1.0	*<1.0*	<1.0	*<1.0*
Se	$\mu g\ l^{-1}$	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.3	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.6	*1.1*
V	$\mu g\ l^{-1}$	6	3.6	*<1.0*	5.4	*<1.0*	8.0	*<1.0*	3.8	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	2.5	*<1.0*	<1.0	*<1.0*
Zn^{H}	$\mu g\ l^{-1}$	8	3.6	*1.5*	4.6	*2.8*	8.8	*8.1*	3.3	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	2.1	*1.1*	1.8	*<1.0*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] Guideline is for Aluminium in freshwater where pH > 6.5.
[B] Guideline assumes As in solution as Arsenic (AsV).
[C] Guideline for Chromium is applicable to Chromium (CrVI) only.
[H] Hardness affected (refer to Guidelines).

Table 8-11. Merran Creek (WC_4) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_4_1.1								WC_4_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	7.43	*0.46*	7.70	*0.13*	7.92	*0.04*	7.48	-	7.91	*0.12*	7.50	*0.25*	7.93	*0.05*	8.37	*0.15*
EC*	µS cm^{-1}	125-2200	1417	*62*	1233	*38*	1213	*78*	606	*5*	2267	*63*	1949	*77*	2304	*6*	1103	*2*
Eh	mV		387	*24*	343	*98*	115	*28*	-19	-	384	*19*	348	*87*	44	*17*	-35	*1*
Ag	µg l^{-1}	0.05	<0.10	*<0.10*	0.14	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.12	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*
Al[A]	mg l^{-1}	0.055	0.03	*0.02*	0.02	*<0.01*	0.08	*0.01*	0.05	*0.03*	0.02	*<0.01*	0.01	*<0.01*	0.02	*<0.01*	0.04	*<0.01*
As[B]	µg l^{-1}	13	<1.0	*<1.0*	4.3	*1.5*	4.7	*2.0*	<1.0	*<1.0*	5.0	*2.8*	7.4	*<1.0*	1.9	*<1.0*	<1.0	*<1.0*
Cd	µg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	µg l^{-1}	2.8	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cr[C]	µg l^{-1}	1	1.3	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.5	*<1.0*	1.5	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.5	*<1.0*
Cu[H]	µg l^{-1}	1.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.1	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Fe	mg l^{-1}	0.30	0.14	*0.02*	0.19	*<0.01*	0.31	*0.06*	0.21	*0.03*	0.14	*<0.01*	0.21	*0.02*	0.20	*0.02*	0.14	*<0.01*
Mn	mg l^{-1}	1.70	0.02	*<0.01*	0.13	*<0.01*	0.19	*0.03*	0.27	*0.17*	0.10	*<0.01*	0.20	*<0.01*	0.28	*0.02*	0.13	*0.04*
Ni[H]	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Pb[H]	µg l^{-1}	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Sb	µg l^{-1}	9	<1.0	*<1.0*	1.3	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.2	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
V	µg l^{-1}	6	6.9	*<1.0*	2.9	*<1.0*	3.5	*<1.0*	2.5	*2.3*	8.9	*<1.0*	2.9	*1.4*	2.8	*<1.0*	2.5	*<1.0*
Zn[H]	µg l^{-1}	8	<1.0	*<1.0*	1.0	*<1.0*	<1.0	*<1.0*	5.7	*1.0*	<1.0	*<1.0*	2.4	*1.7*	<1.0	*<1.0*	1.9	*1.3*

Notes.

The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).

** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*

Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.

[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*

[B] *Guideline assumes As in solution as Arsenic (AsV).*

[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*

[H] *Hardness affected (refer to Guidelines).*

Table 8-12. Merran Creek (WC_6) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_6_1.1								WC_6_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	6.56	*0.21*	6.84	*0.04*	7.12	*0.02*	7.25	*0.14*	6.32	*0.10*	6.83	*0.07*	7.01	*0.04*	7.14	*0.06*
EC*	µS cm^{-1}	125-2200	25	*2*	52	*6*	60	*6*	24	*4*	20	*0*	39	*1*	49	*3*	22	*2*
Eh	mV		282	*26*	218	*4*	138	*19*	143	*4*	318	*20*	220	*1*	139	*24*	167	*10*
Ag	µg l^{-1}	0.05	<0.10	*<0.10*	0.12	*0.10*	<0.10	*<0.10*	0.58	*0.55*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.44	*0.42*
Al[A]	mg l^{-1}	0.055	0.29	*0.11*	0.29	*0.12*	0.44	*0.10*	0.22	*0.04*	0.20	*<0.01*	0.14	*<0.01*	1.32	*1.07*	0.30	*0.03*
As[B]	µg l^{-1}	13	2.1	*<1.0*	8.8	*2.2*	17.8	*1.4*	17.6	*<1.0*	2.1	*<1.0*	8.3	*<1.0*	16.3	*<1.0*	18.3	*1.5*
Cd	µg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	1.5	*1.5*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	µg l^{-1}	2.8	<1.0	*<1.0*	1.8	*<1.0*	2.1	*<1.0*	2.1	*<1.0*	<1.0	*<1.0*	1.4	*<1.0*	2.0	*<1.0*	2.2	*<1.0*
Cr[C]	µg l^{-1}	1	1.8	*<1.0*	1.6	*<1.0*	3.1	*<1.0*	2.8	*<1.0*	1.8	*<1.0*	1.4	*<1.0*	4.6	*2.5*	2.8	*<1.0*
Cu[H]	µg l^{-1}	1.4	3.0	*<1.0*	6.9	*1.8*	11.1	*<1.0*	8.1	*1.5*	2.5	*<1.0*	6.5	*<1.0*	10.5	*1.0*	8.7	*2.1*
Fe	mg l^{-1}	0.30	0.79	*0.08*	2.88	*0.35*	5.27	*0.21*	3.34	*0.60*	0.70	*0.10*	2.38	*0.62*	5.26	*1.18*	3.50	*0.28*
Mn	mg l^{-1}	1.70	0.04	*<0.01*	0.24	*0.07*	0.29	*0.04*	0.23	*0.02*	0.04	*<0.01*	0.18	*<0.01*	0.26	*0.02*	0.25	*0.01*
Ni[H]	µg l^{-1}	11	<1.0	*<1.0*	2.1	*<1.0*	3.8	*<1.0*	3.6	*<1.0*	<1.0	*<1.0*	1.6	*<1.0*	3.6	*<1.0*	3.5	*<1.0*
Pb[H]	µg l^{-1}	3.4	<1.0	*<1.0*	2.1	*<1.0*	7.0	*<1.0*	4.3	*<1.0*	<1.0	*<1.0*	1.7	*<1.0*	5.1	*<1.0*	3.6	*1.6*
Sb	µg l^{-1}	9	<1.0	*<1.0*	1.2	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
V	µg l^{-1}	6	1.6	*<1.0*	4.5	*1.0*	8.8	*<1.0*	10.5	*<1.0*	1.2	*<1.0*	3.8	*1.2*	8.6	*1.4*	9.3	*2.0*
Zn[H]	µg l^{-1}	8	1.7	*<1.0*	15.2	*13.5*	32.5	*7.7*	1.7	*<1.0*	1.1	*<1.0*	3.1	*1.2*	31.1	*9.0*	2.9	*<1.0*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] Guideline is for Aluminium in freshwater where pH > 6.5.
[B] Guideline assumes As in solution as Arsenic (AsV).
[C] Guideline for Chromium is applicable to Chromium (CrVI) only.
[H] Hardness affected (refer to Guidelines).

Table 8-13. Merran Creek (WC_7) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_7_1.1								WC_7_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	8.10	*0.30*	7.66	*0.09*	7.93	*0.29*	7.90	*0.08*	8.31	*0.06*	7.42	*0.07*	7.79	*0.13*	8.20	*0.19*
EC*	µS cm^{-1}	125-2200	103	*5*	152	*3*	169	*5*	81	*3*	321	*26*	339	*3*	430	*45*	188	*5*
Eh	mV		253	*5*	178	*9*	72	*22*	90	*29*	259	*0*	166	*7*	83	*9*	87	*6*
Ag	µg l^{-1}	0.05	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.23	*0.22*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.33	*0.25*
Al^A	mg l^{-1}	0.055	0.47	*0.03*	0.16	*0.06*	0.15	*<0.01*	0.19	*0.02*	0.47	*<0.01*	0.17	*0.02*	0.34	*0.02*	1.16	*0.40*
As^B	µg l^{-1}	13	<1.0	*<1.0*	4.0	*<1.0*	10.6	*<1.0*	21.4	*<1.0*	3.5	*<1.0*	4.7	*<1.0*	11.4	*1.0*	8.6	*<1.0*
Cd	µg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	µg l^{-1}	2.8	1.7	*<1.0*	1.8	*<1.0*	1.3	*<1.0*	<1.0	*<1.0*	1.5	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cr^C	µg l^{-1}	1	2.2	*<1.0*	1.3	*<1.0*	1.7	*<1.0*	1.2	*<1.0*	2.3	*<1.0*	2.5	*1.3*	2.5	*1.0*	3.4	*<1.0*
Cu^H	µg l^{-1}	1.4	4.7	*<1.0*	2.1	*<1.0*	1.6	*<1.0*	1.3	*<1.0*	4.6	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	3.7	*1.0*
Fe	mg l^{-1}	0.30	1.08	*0.02*	1.52	*0.80*	1.69	*0.46*	2.29	*0.17*	1.55	*0.07*	0.56	*0.04*	1.29	*0.48*	2.22	*0.25*
Mn	mg l^{-1}	1.70	0.26	*0.02*	0.74	*0.04*	0.94	*0.04*	0.93	*0.03*	0.19	*0.02*	0.29	*0.02*	0.63	*0.05*	0.47	*0.06*
Ni^H	µg l^{-1}	11	1.8	*<1.0*	2.2	*<1.0*	2.1	*<1.0*	1.2	*<1.0*	2.8	*<1.0*	1.5	*<1.0*	2.2	*<1.0*	2.2	*<1.0*
Pb^H	µg l^{-1}	3.4	1.9	*<1.0*	1.3	*<1.0*	1.4	*<1.0*	<1.0	*<1.0*	2.4	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.4	*<1.0*
Sb	µg l^{-1}	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
V	µg l^{-1}	6	4.2	*<1.0*	3.4	*1.1*	4.4	*<1.0*	4.9	*<1.0*	5.4	*<1.0*	2.5	*<1.0*	6.5	*<1.0*	16.0	*2.2*
Zn^H	µg l^{-1}	8	1.8	*<1.0*	5.6	*4.1*	3.2	*3.2*	1.5	*<1.0*	2.1	*<1.0*	<1.0	*<1.0*	23.4	*17.3*	2.4	*<1.0*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] Guideline is for Aluminium in freshwater where pH > 6.5.
[B] Guideline assumes As in solution as Arsenic (AsV).
[C] Guideline for Chromium is applicable to Chromium (CrVI) only.
[H] Hardness affected (refer to Guidelines).

Table 8-14. Merran Creek (WC_8) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_8_1.1								WC_8_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	7.71	*0.00*	7.59	*0.15*	7.67	*0.20*	8.01	*0.08*	7.32	*0.02*	7.22	*0.08*	7.33	*0.08*	7.59	*0.22*
EC*	μS cm^{-1}	125-2200	414	*6*	424	*14*	445	*7*	198	*5*	651	*5*	576	*6*	647	*26*	319	*32*
Eh	mV		274	*7*	178	*6*	139	*12*	67	*41*	273	*2*	200	*2*	145	*19*	111	*2*
Ag	μg l^{-1}	0.05	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.55	*0.45*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.44	*0.41*
Al^A	mg l^{-1}	0.055	0.73	*0.38*	0.83	*0.03*	0.73	*0.19*	1.23	*0.35*	0.17	*<0.01*	0.16	*0.01*	0.24	*0.02*	0.24	*0.11*
As^B	μg l^{-1}	13	2.4	*<1.0*	3.3	*<1.0*	6.2	*1.2*	11.3	*<1.0*	1.1	*<1.0*	2.7	*<1.0*	3.8	*1.4*	7.4	*3.1*
Cd	μg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	μg l^{-1}	2.8	1.9	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cr^C	μg l^{-1}	1	2.2	*<1.0*	2.1	*<1.0*	4.5	*<1.0*	5.5	*3.0*	1.5	*<1.0*	<1.0	*<1.0*	1.2	*<1.0*	2.0	*<1.0*
Cu^H	μg l^{-1}	1.4	6.1	*1.5*	11.1	*<1.0*	4.6	*2.1*	4.6	*2.0*	1.9	*<1.0*	2.4	*<1.0*	1.5	*<1.0*	1.3	*<1.0*
Fe	mg l^{-1}	0.30	1.82	*0.97*	2.57	*0.13*	2.18	*0.06*	2.78	*0.38*	0.53	*0.07*	1.10	*0.13*	1.18	*0.53*	1.34	*<0.01*
Mn	mg l^{-1}	1.70	0.14	*0.02*	0.17	*<0.01*	0.19	*0.01*	0.17	*0.01*	0.20	*<0.01*	0.23	*0.02*	0.25	*<0.01*	0.23	*0.04*
Ni^H	μg l^{-1}	11	1.8	*<1.0*	1.5	*<1.0*	2.0	*<1.0*	1.7	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.4	*<1.0*	<1.0	*<1.0*
Pb^H	μg l^{-1}	3.4	3.9	*1.5*	7.1	*<1.0*	3.1	*1.1*	3.4	*1.3*	<1.0	*<1.0*	1.3	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Sb	μg l^{-1}	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.0	*1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	μg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
V	μg l^{-1}	6	7.4	*3.7*	7.9	*<1.0*	7.0	*<1.0*	12.0	*2.9*	1.6	*<1.0*	1.9	*<1.0*	2.0	*<1.0*	3.0	*2.1*
Zn^H	μg l^{-1}	8	13.0	*11.0*	2.4	*2.4*	21.7	*9.5*	9.7	*7.7*	1.5	*<1.0*	4.2	*2.9*	9.1	*7.4*	5.0	*1.8*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] Guideline is for Aluminium in freshwater where pH > 6.5.
[B] Guideline assumes As in solution as Arsenic (AsV).
[C] Guideline for Chromium is applicable to Chromium (CrVI) only.
[H] Hardness affected (refer to Guidelines).

Table 8-15. Yarrein Creek (WC_32) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_32_1.1								WC_32_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	7.45	*0.15*	7.13	*0.11*	7.59	*0.03*	7.69	*0.02*	7.44	*0.05*	7.04	*0.02*	7.35	*0.02*	7.41	*0.05*
EC*	µS cm^{-1}	125-2200	4566	*386*	3635	*125*	4145	*375*	2475	*155*	6275	*265*	5550	*40*	5495	*275*	2205	*725*
Eh	mV		317	*29*	194	*9*	113	*14*	67	*14*	321	*24*	210	*3*	150	*4*	89	*9*
Ag	µg l^{-1}	0.05	<0.10	*<0.10*	0.15	*0.11*	0.25	*0.16*	0.55	*0.50*	<0.10	*<0.10*	0.12	*<0.10*	0.10	*<0.10*	0.84	*0.76*
Al[A]	mg l^{-1}	0.055	<0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*
As[B]	µg l^{-1}	13	<1.0	*<1.0*	1.6	*<1.0*	2.8	*<1.0*	4.9	*<1.0*	1.1	*<1.0*	2.3	*<1.0*	3.7	*<1.0*	5.6	*1.4*
Cd	µg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	µg l^{-1}	2.8	2.5	*<1.0*	2.3	*<1.0*	1.8	*<1.0*	1.3	*<1.0*	5.8	*1.8*	6.3	*1.1*	2.6	*<1.0*	2.1	*1.3*
Cr[C]	µg l^{-1}	1	1.4	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.5	*<1.0*	1.4	*<1.0*	<1.0	*<1.0*	1.5	*<1.0*	<1.0	*<1.0*
Cu[H]	µg l^{-1}	1.4	3.4	*<1.0*	2.4	*<1.0*	3.6	*1.3*	4.3	*<1.0*	2.8	*<1.0*	2.3	*<1.0*	2.3	*<1.0*	2.3	*<1.0*
Fe	mg l^{-1}	0.30	0.14	*0.01*	0.20	*<0.01*	0.57	*0.09*	0.79	*0.27*	0.14	*<0.01*	0.49	*0.22*	0.72	*0.37*	2.76	*0.27*
Mn	mg l^{-1}	1.70	2.13	*0.37*	7.32	*0.71*	9.32	*0.05*	13.53	*1.71*	4.29	*0.25*	6.28	*0.84*	6.53	*0.80*	7.07	*0.44*
Ni[H]	µg l^{-1}	11	4.0	*1.5*	3.0	*<1.0*	2.4	*<1.0*	3.1	*<1.0*	6.8	*<1.0*	6.0	*2.1*	3.2	*<1.0*	2.2	*1.4*
Pb[H]	µg l^{-1}	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Sb	µg l^{-1}	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	2.7	*1.4*	<1.0	*<1.0*	<1.0	*<1.0*	2.2	*<1.0*	5.9	*1.9*
V	µg l^{-1}	6	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Zn[H]	µg l^{-1}	8	2.6	*<1.0*	4.0	*<1.0*	2.9	*1.6*	4.8	-	2.6	*<1.0*	2.7	*<1.0*	6.3	*4.2*	3.1	*1.5*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

Table 8-16. Wyam Creek (WC_20) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	WC_20_1.1								WC_20_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	8.09	*0.11*	7.37	*0.13*	7.46	*0.27*	8.02	*0.16*	8.47	*0.03*	7.60	*0.12*	8.04	*0.08*	8.33	*0.09*
EC*	μS cm^{-1}	125-2200	6245	*345*	5775	*225*	5595	*45*	3195	*45*	3755	*225*	3800	*30*	3675	*95*	2065	*146*
Eh	mV		261	*1*	214	*2*	126	*33*	122	*66*	251	*5*	214	*7*	96	*4*	113	*59*
Ag	μg l^{-1}	0.05	0.15	*0.10*	0.47	*0.28*	<0.10	*<0.10*	0.95	*0.84*	<0.10	*<0.10*	0.10	*<0.10*	<0.10	*<0.10*	0.76	*0.68*
Al[A]	mg l^{-1}	0.055	<0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*
As[B]	μg l^{-1}	13	<1.0	*<1.0*	3.5	*<1.0*	4.4	*<1.0*	3.3	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.5	*<1.0*	1.0	*<1.0*
Cd	μg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	μg l^{-1}	2.8	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cr[C]	μg l^{-1}	1	1.9	*<1.0*	1.2	*<1.0*	1.4	*<1.0*	1.8	*<1.0*	1.9	*<1.0*	1.0	*<1.0*	1.1	*<1.0*	1.3	*<1.0*
Cu[H]	μg l^{-1}	1.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Fe	mg l^{-1}	0.30	0.13	*<0.01*	0.16	*0.01*	0.40	*0.21*	0.18	*<0.01*	0.15	*<0.01*	0.16	*0.02*	0.27	*0.05*	0.19	*<0.01*
Mn	mg l^{-1}	1.70	0.23	*<0.01*	0.42	*<0.01*	0.85	*0.04*	0.80	*0.10*	0.16	*0.02*	0.28	*0.06*	0.44	*0.03*	0.44	*0.10*
Ni[H]	μg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Pb[H]	μg l^{-1}	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Sb	μg l^{-1}	9	<1.0	*<1.0*	1.3	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	μg l^{-1}	11	<1.0	*<1.0*	2.3	*1.0*	2.6	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.0	*<1.0*	<1.0	*<1.0*
V	μg l^{-1}	6	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	2.0	*<1.0*
Zn[H]	μg l^{-1}	8	<1.0	*<1.0*	5.1	*1.0*	3.0	*3.0*	2.1	*1.6*	<1.0	*<1.0*	4.9	*<1.0*	1.8	*1.1*	1.0	*<1.0*

Notes.

The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).

** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*

Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.

[A] Guideline is for Aluminium in freshwater where pH > 6.5.

[B] Guideline assumes As in solution as Arsenic (AsV).

[C] Guideline for Chromium is applicable to Chromium (CrVI) only.

[H] Hardness affected (refer to Guidelines).

Table 8-17. Wakool Weir (S1P2) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	S1P2_1.1								S1P2_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	6.57	0.10	6.56	0.02	7.15	0.03	7.19	0.16	6.20	0.13	6.58	0.02	7.17	0.04	7.40	0.18
EC*	µS cm^{-1}	125-2200	82	6	118	1	134	10	60	5	36	6	84	4	83	5	37	11
Eh	mV		370	2	250	6	177	3	145	15	364	2	284	3	163	21	148	9
Ag	µg l^{-1}	0.05	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Al[A]	mg l^{-1}	0.055	0.35	0.05	0.11	0.01	0.12	0.01	0.11	<0.01	0.15	0.04	0.06	<0.01	0.12	0.03	0.08	<0.01
As[B]	µg l^{-1}	13	<1.0	<1.0	3.9	<1.0	4.0	<1.0	9.2	<1.0	1.6	<1.0	7.9	<1.0	11.6	<1.0	8.5	<1.0
Cd	µg l^{-1}	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Co	µg l^{-1}	2.8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cr[C]	µg l^{-1}	1	1.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cu[H]	µg l^{-1}	1.4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fe	mg l^{-1}	0.30	0.47	0.05	2.81	0.32	2.55	0.58	2.49	0.20	0.27	0.02	2.80	0.13	2.84	0.14	1.80	0.67
Mn	mg l^{-1}	1.70	0.21	0.01	0.50	0.06	0.71	0.09	0.59	0.07	0.14	<0.01	0.50	0.01	0.47	0.05	0.32	0.16
Ni[H]	µg l^{-1}	11	<1.0	<1.0	<1.0	<1.0	1.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.3	<1.0	<1.0	<1.0
Pb[H]	µg l^{-1}	3.4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sb	µg l^{-1}	9	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	<1.0	<1.0	<1.0	<1.0
Se	µg l^{-1}	11	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
V	µg l^{-1}	6	<1.0	<1.0	1.4	<1.0	1.0	<1.0	1.9	<1.0	<1.0	<1.0	1.1	<1.0	1.5	<1.0	1.3	<1.0
Zn[H]	µg l^{-1}	8	2.3	1.7	48.1	-	<1.0	<1.0	<1.0	<1.0	1.2	<1.0	1.9	1.9	<1.0	<1.0	1.6	-

Notes.

The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).

** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*

Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.

[A] Guideline is for Aluminium in freshwater where pH > 6.5.

[B] Guideline assumes As in solution as Arsenic (AsV).

[C] Guideline for Chromium is applicable to Chromium (CrVI) only.

[H] Hardness affected (refer to Guidelines).

Table 8-18. Wakool Weir (S1P3) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	S1P3_1.1								S1P3_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	5.89	*0.06*	6.78	*0.02*	7.18	*0.09*	7.13	*0.07*	5.88	*0.13*	6.68	*0.03*	7.11	*0.05*	7.13	*0.03*
EC*	μS cm^{-1}	125-2200	116	*6*	155	*0*	172	*11*	83	*2*	56	*2*	92	*3*	104	*2*	47	*3*
Eh	mV		389	*17*	224	*9*	136	*11*	142	*12*	355	*2*	212	*4*	148	*6*	169	*21*
Ag	μg l^{-1}	0.05	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.36	*0.36*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.20	*0.20*
Al[A]	mg l^{-1}	0.055	0.33	*<0.01*	0.12	*<0.01*	0.11	*0.04*	0.13	*0.05*	0.39	*0.04*	0.14	*0.03*	0.11	*0.02*	0.21	*0.03*
As[B]	μg l^{-1}	13	<1.0	*<1.0*	6.1	*<1.0*	9.5	*2.0*	23.2	*<1.0*	1.4	*<1.0*	4.4	*<1.0*	8.4	*<1.0*	13.9	*1.0*
Cd	μg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	μg l^{-1}	2.8	1.4	*<1.0*	1.2	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.1	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cr[C]	μg l^{-1}	1	1.3	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.3	*<1.0*	1.9	*1.2*	<1.0	*<1.0*	<1.0	*<1.0*
Cu[H]	μg l^{-1}	1.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Fe	mg l^{-1}	0.30	0.54	*0.08*	6.94	*0.05*	5.85	*0.46*	5.07	*0.59*	1.03	*<0.01*	5.96	*1.45*	6.32	*0.55*	4.13	*1.08*
Mn	mg l^{-1}	1.70	0.37	*0.04*	0.86	*0.03*	1.05	*0.11*	0.92	*0.06*	0.26	*0.02*	0.68	*0.04*	0.81	*<0.01*	0.62	*0.13*
Ni[H]	μg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	1.3	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.3	*<1.0*	<1.0	*<1.0*
Pb[H]	μg l^{-1}	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Sb	μg l^{-1}	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	μg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
V	μg l^{-1}	6	<1.0	*<1.0*	1.2	*<1.0*	1.0	*<1.0*	2.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.1	*<1.0*	1.6	*<1.0*
Zn[H]	μg l^{-1}	8	1.8	*<1.0*	6.9	*6.4*	<1.0	*<1.0*	13.1	*12.5*	2.8	*1.5*	<1.0	*<1.0*	<1.0	*<1.0*	6.9	*6.7*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] Guideline is for Aluminium in freshwater where pH > 6.5.
[B] Guideline assumes As in solution as Arsenic (AsV).
[C] Guideline for Chromium is applicable to Chromium (CrVI) only.
[H] Hardness affected (refer to Guidelines).

Table 8-19. Wakool Weir (S1P4) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	S1P4_1.1								S1P4_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	6.53	*0.09*	6.84	*0.04*	7.14	*0.10*	6.76	*0.13*	6.77	*0.06*	6.94	*0.05*	6.96	*0.28*	7.26	*0.00*
EC*	µS cm^{-1}	125-2200	77	*2*	118	*12*	127	*19*	71	*7*	20	*2*	29	*2*	43	*5*	21	*6*
Eh	mV		309	*19*	196	*2*	151	*7*	175	*34*	306	*17*	187	*2*	182	*21*	151	*4*
Ag	µg l^{-1}	0.05	<0.10	*<0.10*	0.12	*<0.10*	<0.10	*<0.10*	0.14	*0.14*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.12	*0.12*
Al^{A}	mg l^{-1}	0.055	0.21	*0.04*	0.08	*0.02*	0.05	*<0.01*	0.03	*0.01*	0.09	*<0.01*	0.04	*<0.01*	0.03	*<0.01*	0.04	*<0.01*
As^{B}	µg l^{-1}	13	<1.0	*<1.0*	3.4	*<1.0*	6.5	*1.4*	5.9	*4.4*	<1.0	*<1.0*	2.0	*<1.0*	3.4	*<1.0*	9.1	*1.3*
Cd	µg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	µg l^{-1}	2.8	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cr^{C}	µg l^{-1}	1	1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	2.7	*2.1*	<1.0	*<1.0*	1.2	*<1.0*
Cu^{H}	µg l^{-1}	1.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Fe	mg l^{-1}	0.30	0.85	*0.14*	2.93	*0.67*	4.34	*1.53*	3.32	*1.28*	0.56	*0.05*	1.05	*0.18*	1.38	*0.16*	1.71	*0.47*
Mn	mg l^{-1}	1.70	0.28	*<0.01*	0.72	*0.14*	1.05	*0.44*	1.13	*0.19*	0.07	*<0.01*	0.13	*<0.01*	0.22	*0.04*	0.20	*0.05*
Ni^{H}	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	1.2	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.2	*<1.0*	<1.0	*<1.0*
Pb^{H}	µg l^{-1}	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Sb	µg l^{-1}	9	<1.0	*<1.0*	1.1	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
V	µg l^{-1}	6	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.3	*<1.0*
Zn^{H}	µg l^{-1}	8	<1.0	*<1.0*	17.5	*4.9*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.0	*1.0*	1.7	*1.7*	13.7	*13.3*

Notes.

The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).

** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*

Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.

[A] Guideline is for Aluminium in freshwater where pH > 6.5.

[B] Guideline assumes As in solution as Arsenic (AsV).

[C] Guideline for Chromium is applicable to Chromium (CrVI) only.

[H] Hardness affected (refer to Guidelines).

Table 8-20. Genoe Creek (S2P4) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	S2P4_1.1								S2P4_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	6.41	*0.23*	6.64	*0.02*	6.82	*0.41*	7.28	*0.02*	6.43	*0.24*	6.79	*0.01*	7.18	*0.12*	7.18	*0.15*
EC*	µS cm^{-1}	125-2200	37	*3*	62	*2*	61	*3*	37	*3*	54	*1*	73	*3*	82	*2*	46	*0*
Eh	mV		314	*1*	225	*17*	212	*51*	168	*9*	307	*2*	235	*5*	182	*19*	151	*8*
Ag	µg l^{-1}	0.05	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*
Al^{A}	mg l^{-1}	0.055	0.28	*0.05*	0.06	*0.01*	0.09	*<0.01*	0.08	*<0.01*	0.36	*0.04*	0.34	*0.04*	0.97	*0.70*	0.41	*0.18*
As^{B}	µg l^{-1}	13	<1.0	*<1.0*	2.4	*<1.0*	4.3	*3.7*	18.8	*2.6*	3.4	*<1.0*	8.4	*<1.0*	24.0	*2.9*	32.9	*4.1*
Cd	µg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	µg l^{-1}	2.8	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cr^{C}	µg l^{-1}	1	1.2	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.5	*<1.0*	3.5	*2.2*	3.2	*<1.0*	1.9	*<1.0*
Cu^{H}	µg l^{-1}	1.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	4.1	*<1.0*	5.9	*<1.0*	4.6	*<1.0*	4.1	*1.3*
Fe	mg l^{-1}	0.30	0.37	*0.02*	0.68	*0.17*	1.15	*0.93*	2.07	*0.06*	1.21	*0.14*	2.40	*0.05*	3.97	*0.77*	3.47	*0.36*
Mn	mg l^{-1}	1.70	0.14	*<0.01*	0.51	*0.03*	0.44	*0.19*	0.72	*0.03*	0.07	*<0.01*	0.17	*0.01*	0.19	*<0.01*	0.23	*<0.01*
Ni^{H}	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	1.8	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.1	*<1.0*	2.3	*<1.0*	<1.0	*<1.0*
Pb^{H}	µg l^{-1}	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.8	*<1.0*	3.1	*<1.0*	3.7	*<1.0*	2.7	*<1.0*
Sb	µg l^{-1}	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
V	µg l^{-1}	6	<1.0	*<1.0*	<1.0	*<1.0*	1.0	*<1.0*	2.2	*<1.0*	2.9	*<1.0*	4.3	*<1.0*	7.5	*1.7*	7.0	*2.8*
Zn^{H}	µg l^{-1}	8	<1.0	*<1.0*	<1.0	-	<1.0	*<1.0*	<1.0	*<1.0*	1.5	*<1.0*	7.5	-	2.1	*1.3*	1.4	*<1.0*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

Table 8-21. Genoe Creek (S2P10) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	S2P10_1.1								S2P10_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	7.05	*0.17*	7.10	*0.13*	7.55	*0.15*	7.74	*0.39*	8.19	*0.05*	7.33	*0.10*	7.67	*0.28*	7.33	*0.09*
EC*	µS cm^{-1}	125-2200	1094	*4*	1128	*7*	1123	*14*	444	*144*	2113	*35*	1519	*n/a*	2060	*3*	904	*340*
Eh	mV		298	*20*	234	*13*	207	*61*	135	*34*	289	*7*	203	*10*	205	*28*	166	*18*
Ag	µg l^{-1}	0.05	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.16	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.20	*<0.10*
Al^A	mg l^{-1}	0.055	<0.01	*<0.01*	0.04	*0.02*	0.02	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*
As^B	µg l^{-1}	13	1.6	*<1.0*	16.9	*2.8*	25.9	*<1.0*	28.2	*6.1*	<1.0	*<1.0*	3.1	*<1.0*	4.3	*1.5*	3.2	*1.4*
Cd	µg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	µg l^{-1}	2.8	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cr^C	µg l^{-1}	1	1.4	*<1.0*	1.2	*<1.0*	1.0	*<1.0*	<1.0	*<1.0*	1.8	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cu^H	µg l^{-1}	1.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Fe	mg l^{-1}	0.30	0.16	*0.01*	0.64	*0.21*	1.24	*0.10*	0.57	*0.27*	0.16	*0.02*	0.23	*0.06*	0.31	*0.15*	0.29	*0.08*
Mn	mg l^{-1}	1.70	0.10	*<0.01*	0.23	*0.06*	0.34	*0.03*	0.31	*0.11*	0.05	*<0.01*	0.08	*0.01*	0.15	*<0.01*	0.19	*0.09*
Ni^H	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	1.5	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.2	*<1.0*	<1.0	*<1.0*
Pb^H	µg l^{-1}	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Sb	µg l^{-1}	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.6	*1.2*
V	µg l^{-1}	6	<1.0	*<1.0*	1.3	*<1.0*	2.4	*<1.0*	2.9	*2.0*	1.1	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.1	*<1.0*
Zn^H	µg l^{-1}	8	<1.0	*<1.0*	<1.0	-	2.0	*2.0*	1.6	*1.2*	<1.0	*<1.0*	<1.0	-	<1.0	*<1.0*	<1.0	*<1.0*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

Table 8-22. Mallan Bridge (S3P1) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	S3P1_1.1								S3P1_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	7.54	*0.09*	7.38	*0.02*	7.41	*0.17*	7.23	*0.28*	7.65	*0.08*	7.30	*0.06*	7.56	*0.01*	7.31	*0.00*
EC*	$\mu S\ cm^{-1}$	125-2200	99	*12*	119	*11*	179	*3*	91	*17*	114	*9*	137	*2*	180	*9*	103	*0*
Eh	mV		275	*18*	187	*0*	169	*40*	141	*14*	264	*15*	204	*6*	151	*22*	125	*0*
Ag	$\mu g\ l^{-1}$	0.05	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.10	*<0.10*	<0.10	*<0.10*	0.14	*<0.10*
Al[A]	$mg\ l^{-1}$	0.055	0.38	*0.02*	0.20	*0.02*	0.25	*0.06*	0.14	*0.08*	0.31	*<0.01*	0.22	*0.02*	0.18	*0.14*	0.23	*<0.01*
As[B]	$\mu g\ l^{-1}$	13	2.2	*<1.0*	11.5	*2.2*	10.0	*2.0*	10.6	*4.5*	2.5	*<1.0*	10.7	*1.9*	6.0	*6.0*	8.8	*<1.0*
Cd	$\mu g\ l^{-1}$	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	$\mu g\ l^{-1}$	2.8	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Cr[C]	$\mu g\ l^{-1}$	1	1.6	*<1.0*	1.0	*<1.0*	1.5	*<1.0*	1.1	*<1.0*	1.9	*<1.0*	1.1	*<1.0*	3.2	*2.2*	1.3	*<1.0*
Cu[H]	$\mu g\ l^{-1}$	1.4	1.1	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.3	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Fe	$mg\ l^{-1}$	0.30	0.90	*0.11*	2.05	*0.22*	3.67	*0.26*	3.45	*0.90*	1.11	*0.18*	1.65	*0.47*	2.11	*0.25*	2.64	*<0.01*
Mn	$mg\ l^{-1}$	1.70	0.11	*<0.01*	0.29	*0.04*	0.63	*0.03*	0.65	*0.16*	0.08	*0.02*	0.16	*<0.01*	0.32	*<0.01*	0.48	*<0.01*
Ni[H]	$\mu g\ l^{-1}$	11	1.4	*<1.0*	1.6	*<1.0*	2.2	*<1.0*	1.1	*<1.0*	1.8	*<1.0*	1.3	*<1.0*	2.4	*1.4*	1.2	*<1.0*
Pb[H]	$\mu g\ l^{-1}$	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Sb	$\mu g\ l^{-1}$	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.1	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	$\mu g\ l^{-1}$	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
V	$\mu g\ l^{-1}$	6	2.6	*<1.0*	4.5	*<1.0*	2.4	*<1.0*	4.0	*3.1*	2.5	*<1.0*	2.8	*<1.0*	3.2	*<1.0*	5.5	*<1.0*
Zn[H]	$\mu g\ l^{-1}$	8	1.2	*<1.0*	<1.0	-	<1.0	*<1.0*	1.1	*<1.0*	<1.0	<1.0	5.0	-	<1.0	*<1.0*	4.8	*<1.0*

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*
Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] Guideline is for Aluminium in freshwater where pH > 6.5.
[B] Guideline assumes As in solution as Arsenic (AsV).
[C] Guideline for Chromium is applicable to Chromium (CrVI) only.
[H] Hardness affected (refer to Guidelines).

Table 8-23. Mallan Bridge (S3P7) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	S3P7_1.1								S3P7_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	7.51	*0.05*	7.41	*0.04*	7.55	*0.15*	7.73	*0.09*	7.52	*0.13*	7.26	*0.00*	7.51	*0.13*	6.72	*1.15*
EC*	μS cm^{-1}	125-2200	30	*0*	34	*0*	41	*1*	22	*1*	23	*1*	27	*1*	27	*1*	31	*19*
Eh	mV		272	*17*	202	*2*	174	*26*	108	*8*	287	*24*	218	*1*	185	*35*	213	*95*
Ag	μg l^{-1}	0.05	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.44	*0.42*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.41	*<0.10*
Al^{A}	mg l^{-1}	0.055	0.34	*0.02*	0.54	*0.16*	0.31	*0.05*	1.42	*0.69*	0.42	*0.04*	0.25	*0.07*	1.48	*1.22*	0.55	*0.48*
As^{B}	μg l^{-1}	13	<1.0	*<1.0*	1.8	*<1.0*	9.0	*7.0*	6.9	*<1.0*	2.9	*<1.0*	5.9	*<1.0*	6.6	*3.6*	5.3	*5.0*
Cd	μg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	μg l^{-1}	2.8	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.7	*1.2*
Cr^{C}	μg l^{-1}	1	1.6	*<1.0*	1.4	*<1.0*	1.0	*<1.0*	3.3	*<1.0*	1.7	*<1.0*	1.1	*<1.0*	2.8	*<1.0*	1.7	*<1.0*
Cu^{H}	μg l^{-1}	1.4	1.7	*<1.0*	3.0	*<1.0*	1.6	*<1.0*	5.8	*2.0*	1.9	*<1.0*	1.4	*<1.0*	2.9	*<1.0*	2.9	*2.3*
Fe	mg l^{-1}	0.30	0.40	*0.04*	0.63	*0.11*	0.67	*0.03*	1.82	*0.33*	0.49	*0.03*	0.42	*0.04*	1.14	*0.73*	0.61	*0.37*
Mn	mg l^{-1}	1.70	0.11	*0.06*	0.28	*0.04*	0.43	*0.03*	0.60	*0.12*	0.16	*<0.01*	0.18	*0.02*	0.27	*0.07*	0.67	*0.33*
Ni^{H}	μg l^{-1}	11	<1.0	*<1.0*	1.2	*<1.0*	1.6	*<1.0*	2.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.7	*<1.0*	1.9	*<1.0*
Pb^{H}	μg l^{-1}	3.4	<1.0	*<1.0*	1.5	*<1.0*	<1.0	*<1.0*	3.3	*1.2*	1.2	*<1.0*	<1.0	*<1.0*	1.8	*<1.0*	<1.0	*<1.0*
Sb	μg l^{-1}	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	μg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
V	μg l^{-1}	6	3.5	*1.2*	6.4	*<1.0*	3.0	*<1.0*	13.5	*3.1*	6.7	*<1.0*	5.9	*<1.0*	10.5	*3.5*	7.3	*7.0*
Zn^{H}	μg l^{-1}	8	1.3	*<1.0*	1.2	-	8.0	*6.0*	3.2	*1.5*	8.1	*6.9*	1.2	*<1.0*	11.7	*8.3*	4.2	*2.0*

Notes.

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** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*

Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.

[A] Guideline is for Aluminium in freshwater where pH > 6.5.

[B] Guideline assumes As in solution as Arsenic (AsV).

[C] Guideline for Chromium is applicable to Chromium (CrVI) only.

[H] Hardness affected (refer to Guidelines).

Table 8-24. Kyalite Boat Ramp (S6P3) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	S6P3_1.1								S6P3_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	6.46	*0.30*	6.69	*0.01*	6.93	*0.15*	7.03	*0.00*	6.15	*0.11*	n.a.	-	n.a.	-	6.78	*0.41*
EC*	µS cm^{-1}	125-2200	31	*3*	97	*5*	106	*1*	55	*2*	60	*2*	n.a.	-	n.a.	-	47	*3*
Eh	mV		307	*22*	256	*7*	178	*37*	137	*2*	326	*18*	n.a.	-	n.a.	-	176	*32*
Ag	µg l^{-1}	0.05	<0.10	*<0.10*	0.12	*<0.10*	<0.10	*<0.10*	0.17	*0.16*	<0.10	*<0.10*	n.a.	-	n.a.	-	0.10	*0.10*
Al^{A}	mg l^{-1}	0.055	0.28	*0.02*	0.12	*0.03*	0.18	*0.12*	0.17	*0.05*	0.30	*<0.01*	n.a.	-	n.a.	-	0.31	*0.06*
As^{B}	µg l^{-1}	13	2.0	*<1.0*	12.4	*1.2*	11.7	*5.7*	20.3	*3.7*	1.5	*<1.0*	n.a.	-	n.a.	-	9.5	*7.3*
Cd	µg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	n.a.	-	n.a.	-	<0.1	*<0.1*
Co	µg l^{-1}	2.8	<1.0	*<1.0*	2.6	*<1.0*	3.1	*<1.0*	2.9	*<1.0*	<1.0	*<1.0*	n.a.	-	n.a.	-	1.1	*<1.0*
Cr^{C}	µg l^{-1}	1	1.2	*<1.0*	10.3	*2.6*	1.0	*<1.0*	1.3	*<1.0*	1.4	*<1.0*	n.a.	-	n.a.	-	1.3	*<1.0*
Cu^{H}	µg l^{-1}	1.4	1.0	*<1.0*	1.2	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.2	*<1.0*	n.a.	-	n.a.	-	2.8	*<1.0*
Fe	mg l^{-1}	0.30	0.45	*0.04*	4.05	*0.17*	4.11	*1.44*	5.58	*0.31*	0.45	*0.05*	n.a.	-	n.a.	-	2.24	*0.62*
Mn	mg l^{-1}	1.70	0.06	*<0.01*	0.67	*0.05*	0.82	*0.09*	0.91	*0.02*	0.06	*<0.01*	n.a.	-	n.a.	-	0.28	*0.09*
Ni^{H}	µg l^{-1}	11	<1.0	*<1.0*	1.9	*<1.0*	2.1	*<1.0*	1.9	*<1.0*	<1.0	*<1.0*	n.a.	-	n.a.	-	1.0	*<1.0*
Pb^{H}	µg l^{-1}	3.4	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	n.a.	-	n.a.	-	2.6	*2.0*
Sb	µg l^{-1}	9	<1.0	*<1.0*	1.2	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	n.a.	-	n.a.	-	<1.0	*<1.0*
Se	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	n.a.	-	n.a.	-	<1.0	*<1.0*
V	µg l^{-1}	6	1.7	*<1.0*	1.8	*<1.0*	1.8	*<1.0*	3.2	*<1.0*	1.4	*<1.0*	n.a.	-	n.a.	-	2.9	*1.1*
Zn^{H}	µg l^{-1}	8	<1.0	*<1.0*	<1.0	-	3.7	*2.7*	<1.0	*<1.0*	1.3	*<1.0*	n.a.	-	n.a.	-	8.3	*7.6*

Notes.

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** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity.*

Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.

[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*

[B] *Guideline assumes As in solution as Arsenic (AsV).*

[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*

[H] *Hardness affected (refer to Guidelines).*

Table 8-25. Kyalite Boat Ramp (S6P6) contaminant and metalloid dynamics data.

Parameter	units	ANZECC Guidelines	S6P6_1.1								S6P6_1.2							
			24 hours		7 days		14 days		35 days		24 hours		7 days		14 days		35 days	
			Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±	Av.	±
pH		6.5-8.0	6.06	*0.06*	6.68	*0.06*	6.78	*0.03*	7.10	*0.11*	5.96	*0.19*	6.56	*0.15*	6.68	*0.09*	7.22	*0.04*
EC*	µS cm^{-1}	125-2200	17	*0*	62	*3*	87	*5*	31	*5*	17	*0*	37	*7*	78	*19*	24	*1*
Eh	mV		376	*47*	249	*7*	157	*19*	166	*35*	372	*23*	243	*13*	205	*11*	156	*2*
Ag	µg l^{-1}	0.05	<0.10	*<0.10*	0.40	*0.37*	<0.10	*<0.10*	0.11	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	<0.10	*<0.10*	0.12	*0.10*
Al[A]	mg l^{-1}	0.055	0.32	*<0.01*	0.10	*0.01*	0.71	*0.25*	0.17	*<0.01*	0.35	*0.04*	0.33	*0.02*	0.53	*0.05*	0.74	*<0.01*
As[B]	µg l^{-1}	13	1.9	*<1.0*	10.2	*2.1*	13.9	*<1.0*	17.0	*2.3*	2.7	*<1.0*	5.2	*1.8*	10.0	*<1.0*	18.5	*1.1*
Cd	µg l^{-1}	0.2	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*	<0.1	*<0.1*
Co	µg l^{-1}	2.8	<1.0	*<1.0*	1.1	*<1.0*	1.5	*<1.0*	1.2	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.1	*<1.0*
Cr[C]	µg l^{-1}	1	1.6	*<1.0*	<1.0	*<1.0*	1.7	*<1.0*	<1.0	*<1.0*	11.6	*4.6*	1.2	*<1.0*	1.4	*<1.0*	2.1	*<1.0*
Cu[H]	µg l^{-1}	1.4	1.2	*<1.0*	1.7	*<1.0*	1.7	*<1.0*	1.2	*<1.0*	1.6	*<1.0*	2.6	*<1.0*	3.5	*<1.0*	4.9	*<1.0*
Fe	mg l^{-1}	0.30	0.59	*0.05*	3.79	*0.04*	4.74	*1.15*	2.90	*0.25*	0.76	*0.11*	1.78	*0.47*	2.50	*0.09*	3.07	*0.10*
Mn	mg l^{-1}	1.70	0.04	*<0.01*	0.40	*<0.01*	0.53	*0.08*	0.36	*0.06*	0.05	*0.01*	0.12	*0.05*	0.24	*<0.01*	0.24	*0.02*
Ni[H]	µg l^{-1}	11	<1.0	*<1.0*	1.4	*<1.0*	1.9	*<1.0*	2.1	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	1.3	*<1.0*	1.9	*<1.0*
Pb[H]	µg l^{-1}	3.4	<1.0	*<1.0*	2.8	*<1.0*	2.9	*<1.0*	2.1	*<1.0*	1.4	*<1.0*	2.8	*1.6*	3.6	*<1.0*	7.6	*<1.0*
Sb	µg l^{-1}	9	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
Se	µg l^{-1}	11	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*	<1.0	*<1.0*
V	µg l^{-1}	6	1.8	*<1.0*	3.5	*<1.0*	3.8	*<1.0*	3.6	*<1.0*	2.1	*<1.0*	4.0	*1.4*	3.8	*<1.0*	7.3	*<1.0*
Zn[H]	µg l^{-1}	8	5.1	*3.9*	<1.0	-	7.6	*6.9*	12.7	*10.8*	37.3	*6.6*	1.3	-	<1.0	*<1.0*	1.8	*<1.0*

Notes.
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Values outside the ranges defined in the ANZECC guidelines are indicated with red text. The deviation from the mean is represented by '±'.
[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

Table 8-26. Monosulfide formation potential reactive iron data.

Site Name	Site ID	Total Fe (mg/kg)		Fe(II) (mg/kg)	
		Av.	**+/-**	**Av.**	**+/-**
Wakool River	WC18_1.1	324	23	76	1
Niemur River	WC31_1.1	2,344	-	1,327	-
Barbers Creek	WC25_1.1	3,931	593	2,057	227
Merran Creek	WC6_1.1	1,921	152	1,074	94

The deviation from the mean is represented by '±'.

Table 8-27. Monosulfide formation potential data (Day 0).

Site Name	Site ID	pH		Eh (mV)	
		Av.	**+/-**	**Av.**	**+/-**
Wakool River	WC18_1.1	6.73	*0.01*	283	*3*
Niemur River	WC31_1.1	i.s.	-	i.s.	-
Barbers Creek	WC25_1.1	6.72	*0.22*	345	*47*
Merran Creek	WC6_1.1	6.64	*0.00*	263	*7*

The deviation from the mean is represented by '±'.

i.s. Insufficient sample for analysis.

Table 8-28. Monosulfide formation potential data (Week 7).

Site Name	Site ID	AVS (%S)		Pyrite (%S)		Elemental S (%S)		pH		Eh (mV)		Dissolved S^{2-} (µg/L)	
		Av.	**+/-**	**Av.**	**+/-**	**Av.**	**+/-**	**Av.**	**+/-**	**Av.**	**+/-**	**Av.**	**+/-**
Wakool River	WC18_1.1	<0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	3.99	*0.01*	312	*16*	<0.1	*<0.1*
Niemur River	WC31_1.1	<0.01	-	<0.01	-	<0.01	-	4.29	-	363	-	<0.1	-
Barbers Creek	WC25_1.1	0.01	*0.01*	<0.01	*<0.01*	<0.01	*<0.01*	4.33	*0.00*	345	*9*	391	*74.4*
Merran Creek	WC6_1.1	<0.01	*<0.01*	<0.01	*<0.01*	<0.01	*<0.01*	4.07	*0.01*	418	*9*	0.3	*<0.1*

The deviation from the mean is represented by '±'.

Table 8-29. Wakool River (WC_13, WC_18, WC_24) reactive metals data (mg/kg dry wt.).

Parameter	units	Wakool River						
		WC_13_1.1	WC_13_1.2		WC_18_1.1	WC_18_1.2	WC_24_1.1	WC_24_1.2
		Av.	Av.	±	Av.	Av.	Av.	Av.
Ag	mg kg^{-1}	0.001	0.002	*0.002*	0.004	0.003	0.001	0.001
Al	mg kg^{-1}	176	168	*2*	58	51	394	338
As	mg kg^{-1}	0.32	0.54	*0.03*	0.08	0.19	0.65	0.67
Cd	mg kg^{-1}	0.009	0.012	*<0.001*	<0.001	0.002	0.073	0.008
Co	mg kg^{-1}	1.37	1.14	*0.03*	0.42	0.37	5.99	1.59
Cr	mg kg^{-1}	0.11	0.10	*<0.01*	0.04	0.04	0.23	0.20
Cu	mg kg^{-1}	1.72	1.91	*0.05*	0.32	0.29	5.10	3.92
Fe	mg kg^{-1}	574	605	*14*	161	134	2,983	1,213
Mn	mg kg^{-1}	119	51	*1*	38	14	98	77
Ni	mg kg^{-1}	1.17	1.23	*0.03*	0.26	0.31	8.06	2.16
Pb	mg kg^{-1}	2.57	2.54	*0.04*	0.63	0.72	4.80	5.45
Sb	mg kg^{-1}	0.001	0.012	*0.010*	0.001	0.003	0.006	0.005
Se	mg kg^{-1}	0.08	0.07	*<0.01*	<0.01	0.05	0.14	0.16
V	mg kg^{-1}	3.41	4.08	*0.06*	0.76	0.93	8.48	8.42
Zn	mg kg^{-1}	3.89	4.16	*0.11*	0.93	1.00	16.61	7.55

The deviation from the mean is represented by '±'.

Table 8-30. Niemur River (WC_22, WC_31) and Jimaringle Creek (WC_36, WC_44) reactive metals data (mg/kg dry wt.).

Parameter	units	Niemur River				Jimaringle Creek			
		WC_22_1.1	WC_22_1.2	WC_31_1.1	WC_31_1.2	WC_36_1.1	WC_36_1.2	WC_44_1.1	WC_44_1.2
		Av.	Av.	Av.	Av.	Av.	Av.	Av.	Av.
Ag	mg kg^{-1}	0.001	0.001	i.s.	0.001	0.002	0.008	0.005	0.001
Al	mg kg^{-1}	353	290	i.s.	122	449	490	564	568
As	mg kg^{-1}	0.99	0.71	i.s.	0.34	0.78	0.69	0.40	1.23
Cd	mg kg^{-1}	0.010	0.008	i.s.	0.006	0.100	0.051	0.131	0.008
Co	mg kg^{-1}	1.57	3.03	i.s.	0.54	6.95	3.84	26.50	4.22
Cr	mg kg^{-1}	0.25	0.23	i.s.	0.15	0.20	0.15	0.38	0.27
Cu	mg kg^{-1}	4.03	2.41	i.s.	1.12	3.57	4.42	3.95	4.24
Fe	mg kg^{-1}	799	1,448	i.s.	464	3,051	1,837	4,229	2,930
Mn	mg kg^{-1}	50	43	i.s.	32	480	530	11,246	1,779
Ni	mg kg^{-1}	1.37	1.35	i.s.	0.60	7.26	4.49	16.04	2.76
Pb	mg kg^{-1}	4.78	2.88	i.s.	1.45	3.62	2.85	1.51	3.64
Sb	mg kg^{-1}	0.008	0.007	i.s.	0.001	0.009	0.007	0.007	0.010
Se	mg kg^{-1}	0.07	0.08	i.s.	0.01	0.22	0.22	0.44	0.59
V	mg kg^{-1}	8.67	5.09	i.s.	4.46	5.68	4.60	2.25	7.78
Zn	mg kg^{-1}	4.39	5.04	i.s.	2.64	17.67	14.01	38.76	5.45

The deviation from the mean is represented by '±'.

i.s. Insufficient sample for analysis.

Table 8-31. Barbers Creek (WC_25) and Mallan Mallan Creek (WC_15, WC_17) reactive metals data (mg/kg dry wt.).

Parameter	units	Barbers Creek			Mallan Mallan Creek			
		WC_25_1.1	WC_25_1.2		WC_15_1.1	WC_15_1.2	WC_17_1.1	WC_17_1.2
		Av.	Av.	±	Av.	Av.	Av.	Av.
Ag	mg kg^{-1}	0.005	0.002	*<0.001*	0.003	0.002	0.006	0.005
Al	mg kg^{-1}	218	231	*3*	317	348	538	405
As	mg kg^{-1}	0.83	0.89	*0.04*	1.08	1.95	1.29	0.82
Cd	mg kg^{-1}	0.013	0.013	*0.001*	0.005	0.011	0.008	0.009
Co	mg kg^{-1}	2.73	1.95	*0.06*	1.37	2.68	2.04	2.94
Cr	mg kg^{-1}	0.15	0.17	*0.01*	0.27	0.38	0.46	0.35
Cu	mg kg^{-1}	2.88	3.39	*0.02*	2.83	3.46	5.01	3.50
Fe	mg kg^{-1}	1,469	1,815	*38*	844	2,172	1,689	3,565
Mn	mg kg^{-1}	149	142	*2*	140	656	168	194
Ni	mg kg^{-1}	2.24	1.89	*0.05*	1.18	2.89	1.91	1.76
Pb	mg kg^{-1}	3.55	4.18	*0.03*	3.95	5.30	4.79	3.83
Sb	mg kg^{-1}	0.021	0.008	*0.001*	0.005	0.007	0.008	0.002
Se	mg kg^{-1}	0.09	0.06	*0.01*	0.25	0.36	0.37	0.26
V	mg kg^{-1}	4.62	5.96	*0.13*	4.92	7.79	7.51	5.83
Zn	mg kg^{-1}	4.50	10.18	*5.40*	2.08	2.91	3.48	3.23

The deviation from the mean is represented by '±'.

Table 8-32. Merran Creek (WC_4, WC_6, WC_7, WC_8) reactive metals data (mg/kg dry wt.).

Parameter	units	Merran Creek								
		WC_4_1.1	WC_4_1.2	WC_6_1.1	WC_6_1.2	WC_7_1.1	WC_7_1.2	WC_8_1.1	WC_8_1.2	
		Av.	Av.	Av.	Av.	Av.	Av.	Av.	Av.	±
Ag	mg kg^{-1}	0.001	<0.001	0.001	0.001	0.002	0.001	0.001	0.002	*0.001*
Al	mg kg^{-1}	142	249	257	237	385	396	207	240	*7*
As	mg kg^{-1}	0.58	0.71	0.55	0.53	0.40	0.67	0.56	0.61	*0.03*
Cd	mg kg^{-1}	0.006	0.009	0.008	0.008	0.014	0.018	0.014	0.012	*<0.001*
Co	mg kg^{-1}	1.20	2.25	1.24	0.98	3.60	3.86	2.93	2.11	*0.12*
Cr	mg kg^{-1}	0.23	0.26	0.11	0.10	0.25	0.39	0.13	0.21	*0.01*
Cu	mg kg^{-1}	1.46	1.99	4.11	3.88	3.87	4.36	2.44	3.09	*0.14*
Fe	mg kg^{-1}	453	404	1,040	1,099	1,010	1,989	712	1,025	*10*
Mn	mg kg^{-1}	56	127	137	109	426	423	85	86	*3*
Ni	mg kg^{-1}	1.06	1.86	1.44	1.21	2.89	3.43	2.31	2.00	*0.07*
Pb	mg kg^{-1}	2.29	2.60	2.12	2.00	4.01	3.85	3.51	3.73	*0.04*
Sb	mg kg^{-1}	0.013	0.007	0.005	0.004	0.005	0.007	0.006	0.016	*0.006*
Se	mg kg^{-1}	0.11	0.16	0.08	0.07	0.07	0.13	0.07	0.08	*0.01*
V	mg kg^{-1}	4.20	8.16	4.63	4.81	7.27	9.47	6.22	7.52	*0.29*
Zn	mg kg^{-1}	2.90	4.30	4.48	3.89	5.02	5.54	5.42	5.35	*0.06*

The deviation from the mean is represented by '±'.

Table 8-33. Yarrein Creek (WC_32) and Wyam Creek (WC_20) reactive metals data (mg/kg dry wt.).

Parameter	units	Yarrein Creek		Wyam Creek	
		WC_32_1.1	**WC_32_1.2**	**WC_20_1.1**	**WC_20_1.2**
		Av.	**Av.**	**Av.**	**Av.**
Ag	mg kg^{-1}	0.012	0.007	<0.001	<0.001
Al	mg kg^{-1}	778	701	283	339
As	mg kg^{-1}	0.68	0.73	0.41	0.52
Cd	mg kg^{-1}	0.019	0.026	0.021	0.014
Co	mg kg^{-1}	6.33	6.50	2.49	1.72
Cr	mg kg^{-1}	0.71	0.59	0.37	0.26
Cu	mg kg^{-1}	3.97	6.10	3.58	3.51
Fe	mg kg^{-1}	832	1,665	3,286	2,072
Mn	mg kg^{-1}	1,063	874	1,876	904
Ni	mg kg^{-1}	5.44	5.30	2.79	1.81
Pb	mg kg^{-1}	4.22	6.71	2.76	3.73
Sb	mg kg^{-1}	0.005	0.005	0.005	0.005
Se	mg kg^{-1}	0.40	0.51	0.54	0.22
V	mg kg^{-1}	5.88	9.63	6.93	10.19
Zn	mg kg^{-1}	4.80	6.55	5.39	3.83

The deviation from the mean is represented by '±'.

Table 8-34. Wakool Weir (Site 1) reactive metals data (mg/kg dry wt.).

Parameter	units	Wakool Weir						
		S1P2_1.1	S1P2_1.2	S1P3_1.1	S1P3_1.2	S1P4_1.1		S1P4_1.2
		Av.	Av.	Av.	Av.	Av.	±	Av.
Ag	mg kg^{-1}	0.001	0.004	i.s.	i.s.	0.001	*<0.001*	0.003
Al	mg kg^{-1}	121	84	i.s.	i.s.	99	*8*	70
As	mg kg^{-1}	0.44	0.46	i.s.	i.s.	0.31	*0.02*	0.12
Cd	mg kg^{-1}	0.015	0.016	i.s.	i.s.	0.015	*<0.001*	0.007
Co	mg kg^{-1}	1.51	0.96	i.s.	i.s.	1.00	*0.07*	0.40
Cr	mg kg^{-1}	0.08	0.16	i.s.	i.s.	0.07	*0.01*	0.12
Cu	mg kg^{-1}	1.48	1.16	i.s.	i.s.	1.20	*0.07*	0.65
Fe	mg kg^{-1}	1,011	775	i.s.	i.s.	694	*39*	430
Mn	mg kg^{-1}	118	79	i.s.	i.s.	90	*2*	25
Ni	mg kg^{-1}	0.98	0.90	i.s.	i.s.	1.31	*0.12*	0.30
Pb	mg kg^{-1}	1.18	1.23	i.s.	i.s.	1.15	*0.05*	0.82
Sb	mg kg^{-1}	0.001	0.020	i.s.	i.s.	0.004	*0.002*	0.002
Se	mg kg^{-1}	0.03	0.03	i.s.	i.s.	0.03	*0.02*	0.01
V	mg kg^{-1}	1.45	1.64	i.s.	i.s.	1.22	*0.10*	0.73
Zn	mg kg^{-1}	2.64	2.49	i.s.	i.s.	2.37	*0.11*	1.39

The deviation from the mean is represented by '±'.

i.s. Insufficient sample for analysis.

Table 8-35. Genoe Creek (Site 2) and Mallan Bridge (Site 3) reactive metals data (mg/kg dry wt.).

Parameter	units	Wakool Weir				Mallan Bridge			
		S2P4_1.1	**S2P4_1.2**	**S2P10_1.1**	**S2P10_1.2**	**S3P1_1.1**	**S3P1_1.2**	**S3P7_1.1**	**S3P7_1.2**
		Av.	**Av.**	**Av.**	**Av.**	**Av.**	**Av.**	**Av.**	**Av.**
Ag	mg kg^{-1}	0.003	0.002	i.s.	i.s.	i.s.	i.s.	0.001	0.002
Al	mg kg^{-1}	98	186	i.s.	i.s.	i.s.	i.s.	127	83
As	mg kg^{-1}	0.31	1.05	i.s.	i.s.	i.s.	i.s.	0.37	0.46
Cd	mg kg^{-1}	0.004	0.007	i.s.	i.s.	i.s.	i.s.	0.005	0.002
Co	mg kg^{-1}	1.39	1.34	i.s.	i.s.	i.s.	i.s.	0.96	0.79
Cr	mg kg^{-1}	0.10	0.20	i.s.	i.s.	i.s.	i.s.	0.11	0.07
Cu	mg kg^{-1}	1.02	2.61	i.s.	i.s.	i.s.	i.s.	1.94	0.89
Fe	mg kg^{-1}	467	1,240	i.s.	i.s.	i.s.	i.s.	189	136
Mn	mg kg^{-1}	90	77	i.s.	i.s.	i.s.	i.s.	158	86
Ni	mg kg^{-1}	0.56	1.16	i.s.	i.s.	i.s.	i.s.	1.04	0.94
Pb	mg kg^{-1}	1.14	2.47	i.s.	i.s.	i.s.	i.s.	1.72	0.93
Sb	mg kg^{-1}	0.003	0.004	i.s.	i.s.	i.s.	i.s.	0.004	0.004
Se	mg kg^{-1}	0.03	0.03	i.s.	i.s.	i.s.	i.s.	<0.01	0.04
V	mg kg^{-1}	1.23	4.22	i.s.	i.s.	i.s.	i.s.	3.49	2.18
Zn	mg kg^{-1}	1.53	3.24	i.s.	i.s.	i.s.	i.s.	4.08	2.50

The deviation from the mean is represented by '±'.

i.s. Insufficient sample for analysis.

Table 8-36. Kyalite Boat Ramp (Site 6) reactive metals data (mg/kg dry wt.).

Parameter	units	Kyalite Boat Ramp				
		S6P3_1.1	S6P3_1.2	S6P6_1.1	S6P6_1.2	
		Av.	Av.	Av.	Av.	±
Ag	mg kg^{-1}	0.002	0.002	0.004	0.002	*<0.001*
Al	mg kg^{-1}	459	519	332	337	*8*
As	mg kg^{-1}	0.91	0.90	0.73	0.96	*<0.01*
Cd	mg kg^{-1}	0.036	0.028	0.036	0.032	*0.004*
Co	mg kg^{-1}	2.99	2.94	2.71	2.03	*0.05*
Cr	mg kg^{-1}	0.21	0.25	0.18	0.17	*<0.01*
Cu	mg kg^{-1}	5.80	6.19	4.56	4.78	*0.10*
Fe	mg kg^{-1}	1,864	2,178	1,430	1,520	*48*
Mn	mg kg^{-1}	454	455	234	205	*9*
Ni	mg kg^{-1}	2.37	2.36	2.56	2.09	*0.01*
Pb	mg kg^{-1}	7.12	7.29	12.26	13.79	*0.40*
Sb	mg kg^{-1}	<0.001	0.002	0.020	0.005	*0.001*
Se	mg kg^{-1}	0.10	0.10	0.10	0.09	*<0.01*
V	mg kg^{-1}	12.12	14.47	9.37	10.66	*0.20*
Zn	mg kg^{-1}	8.73	9.15	9.30	9.40	*0.16*

The deviation from the mean is represented by '±'.

APPENDIX 2. SUMMARY OF CHANNEL SYSTEM CONTAMINANT AND METALLOID DATA

Table 8-37. Summary of contaminant and metalloid dynamics data for the Wakool River.

Parameter	units	ANZECC Guidelines	Wakool River channel samples		
			Min.	Median	Max.
pH		6.5-8.0	5.88	7.13	8.19
EC*	µS cm^{-1}	125-2,200	17	84	2,113
Eh	mV	-	62	199	389
Ag	µg l^{-1}	0.05	<0.1	<0.1	0.8
Al[A]	mg l^{-1}	0.055	<0.01	0.18	1.48
As[B]	µg l^{-1}	13	<1.0	5.9	32.9
Cd	µg l^{-1}	0.2	<0.1	<0.1	<0.1
Co	µg l^{-1}	2.8	<1.0	<1.0	3.1
Cr[C]	µg l^{-1}	1	<1.0	1.3	11.6
Cu[H]	µg l^{-1}	1.4	<1.0	<1.0	5.9
Fe	mg l^{-1}	0.30	0.16	1.68	7.09
Mn	mg l^{-1}	1.70	<0.01	0.26	1.13
Ni[H]	µg l^{-1}	11	<1.0	1.0	4.4
Pb[H]	µg l^{-1}	3.4	<1.0	<1.0	7.6
Sb	µg l^{-1}	9	<1.0	<1.0	1.2
Se	µg l^{-1}	11	<1.0	<1.0	1.6
V	µg l^{-1}	6	<1.0	2.2	13.5
Zn[H]	µg l^{-1}	8	<1.0	1.5	48.1

Exceeded ANZECC Guideline (x1)	***Exceeded ANZECC Guideline (x10)***	***Exceeded ANZECC Guideline (x100)***

Notes.

The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).

** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity. Values outside the ranges defined in the ANZECC guidelines are indicated with yellow, orange and red background colours.*

[A] Guideline is for Aluminium in freshwater where pH > 6.5.

[B] Guideline assumes As in solution as Arsenic (AsV).

[C] Guideline for Chromium is applicable to Chromium (CrVI) only.

[H] Hardness affected (refer to Guidelines).

Table 8-38. Summary of contaminant and metalloid dynamics data for the Niemur River.

Parameter	units	ANZECC Guidelines	Niemur River channel samples		
			Min.	Median	Max.
pH		6.5-8.0	5.82	7.58	8.81
EC*	µS cm^{-1}	125-2,200	36	123	204
Eh	mV	-	-10	176	367
Ag	µg l^{-1}	0.05	<0.1	<0.1	1.8
Al[A]	mg l^{-1}	0.055	0.06	3.14	34.58
As[B]	µg l^{-1}	13	1.6	19.1	41.6
Cd	µg l^{-1}	0.2	<0.1	<0.1	0.1
Co	µg l^{-1}	2.8	<1.0	4.4	14.0
Cr[C]	µg l^{-1}	1	<1.0	7.1	26.2
Cu[H]	µg l^{-1}	1.4	<1.0	12.7	79.7
Fe	mg l^{-1}	0.30	0.33	7.61	34.10
Mn	mg l^{-1}	1.70	0.04	0.20	0.54
Ni[H]	µg l^{-1}	11	<1.0	4.7	13.4
Pb[H]	µg l^{-1}	3.4	<1.0	12.5	71.1
Sb	µg l^{-1}	9	<1.0	<1.0	1.4
Se	µg l^{-1}	11	<1.0	<1.0	1.6
V	µg l^{-1}	6	<1.0	29.8	140.9
Zn[H]	µg l^{-1}	8	<1.0	16.2	78.0

Exceeded ANZECC Guideline (x1) ***Exceeded ANZECC Guideline (x10)*** ***Exceeded ANZECC Guideline (x100)***

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity. Values outside the ranges defined in the ANZECC guidelines are indicated with yellow, orange and red background colours.*
[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

Table 8-39. Summary of contaminant and metalloid dynamics data for the Jimaringle Creek.

Parameter	units	ANZECC Guidelines	Jimaringle Creek channel samples		
			Min.	Median	Max.
pH		6.5-8.0	6.06	7.05	7.61
EC*	µS cm^{-1}	125-2,200	1,207	2,646	5,090
Eh	mV	-	67	162	356
Ag	µg l^{-1}	0.05	<0.1	<0.1	1.2
Al[A]	mg l^{-1}	0.055	<0.01	<0.01	0.03
As[B]	µg l^{-1}	13	<1.0	5.0	26.0
Cd	µg l^{-1}	0.2	<0.1	<0.1	0.1
Co	µg l^{-1}	2.8	2.3	13.9	44.5
Cr[C]	µg l^{-1}	1	<1.0	1.5	1.8
Cu[H]	µg l^{-1}	1.4	1.9	3.0	6.5
Fe	mg l^{-1}	0.30	0.18	7.31	39.28
Mn	mg l^{-1}	1.70	2.67	19.14	58.01
Ni[H]	µg l^{-1}	11	1.8	6.5	19.9
Pb[H]	µg l^{-1}	3.4	<1.0	<1.0	<1.0
Sb	µg l^{-1}	9	<1.0	<1.0	1.5
Se	µg l^{-1}	11	<1.0	<1.0	4.3
V	µg l^{-1}	6	<1.0	1.0	4.3
Zn[H]	µg l^{-1}	8	3.1	5.8	23.9

Exceeded ANZECC Guideline (x1)	Exceeded ANZECC Guideline (x10)	Exceeded ANZECC Guideline (x100)

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity. Values outside the ranges defined in the ANZECC guidelines are indicated with yellow, orange and red background colours.*
[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

Table 8-40. Summary of contaminant and metalloid dynamics data for the Barbers Creek.

Parameter	units	ANZECC Guidelines	Barber Creek channel samples	
			Min.	**Max.**
pH		6.5-8.0	7.03	7.65
EC*	µS cm^{-1}	125-2,200	18	63
Eh	mV	-	91	282
Ag	µg l^{-1}	0.05	<0.1	0.5
Al[A]	mg l^{-1}	0.055	0.09	0.24
As[B]	µg l^{-1}	13	1.4	28.9
Cd	µg l^{-1}	0.2	<0.1	<0.1
Co	µg l^{-1}	2.8	<1.0	1.3
Cr[C]	µg l^{-1}	1	<1.0	2.2
Cu[H]	µg l^{-1}	1.4	1.4	4.9
Fe	mg l^{-1}	0.30	0.51	5.54
Mn	mg l^{-1}	1.70	0.05	0.47
Ni[H]	µg l^{-1}	11	<1.0	2.1
Pb[H]	µg l^{-1}	3.4	<1.0	4.2
Sb	µg l^{-1}	9	<1.0	<1.0
Se	µg l^{-1}	11	<1.0	<1.0
V	µg l^{-1}	6	1.4	4.9
Zn[H]	µg l^{-1}	8	<1.0	13.9

Exceeded ANZECC Guideline (x1) ***Exceeded ANZECC Guideline (x10)*** ***Exceeded ANZECC Guideline (x100)***

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity. Values outside the ranges defined in the ANZECC guidelines are indicated with yellow, orange and red background colours.*
[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*
[B] *Guideline assumes As in solution as Arsenic (AsV).*
[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*
[H] *Hardness affected (refer to Guidelines).*

Table 8-41. Summary of contaminant and metalloid dynamics data for the Mallan Mallan Creek.

Parameter	units	ANZECC Guidelines	Mallan Mallan Creek channel samples		
			Min.	**Median**	**Max.**
pH		6.5-8.0	7.22	7.75	8.35
EC*	µS cm^{-1}	125-2,200	1,141	2,761	4,170
Eh	mV	-	-7	142	319
Ag	µg l^{-1}	0.05	<0.1	<0.1	0.5
Al[A]	mg l^{-1}	0.055	<0.01	0.01	0.57
As[B]	µg l^{-1}	13	2.1	15.0	34.6
Cd	µg l^{-1}	0.2	<0.1	<0.1	<0.1
Co	µg l^{-1}	2.8	<1.0	<1.0	2.3
Cr[C]	µg l^{-1}	1	1.1	1.5	2.7
Cu[H]	µg l^{-1}	1.4	<1.0	<1.0	1.3
Fe	mg l^{-1}	0.30	0.14	0.64	3.18
Mn	mg l^{-1}	1.70	0.12	0.51	1.00
Ni[H]	µg l^{-1}	11	<1.0	2.1	4.3
Pb[H]	µg l^{-1}	3.4	<1.0	<1.0	<1.0
Sb	µg l^{-1}	9	<1.0	<1.0	1.3
Se	µg l^{-1}	11	<1.0	<1.0	4.2
V	µg l^{-1}	6	<1.0	2.9	8.0
Zn[H]	µg l^{-1}	8	<1.0	1.6	8.8

Exceeded ANZECC Guideline (x1)	***Exceeded ANZECC Guideline (x10)***	***Exceeded ANZECC Guideline (x100)***

Notes.
The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).
** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity. Values outside the ranges defined in the ANZECC guidelines are indicated with yellow, orange and red background colours.*
[A] Guideline is for Aluminium in freshwater where pH > 6.5.
[B] Guideline assumes As in solution as Arsenic (AsV).
[C] Guideline for Chromium is applicable to Chromium (CrVI) only.
[H] Hardness affected (refer to Guidelines).

Table 8-42. Summary of contaminant and metalloid dynamics data for the Merran Creek.

Parameter	units	ANZECC Guidelines	Merran Creek channel samples		
			Min.	Median	Max.
pH		6.5-8.0	6.32	7.59	8.37
EC*	µS cm^{-1}	125-2,200	20	330	2,304
Eh	mV	-	-35	167	387
Ag	µg l^{-1}	0.05	<0.1	<0.1	0.6
Al[A]	mg l^{-1}	0.055	0.01	0.21	1.32
As[B]	µg l^{-1}	13	<1.0	4.7	21.4
Cd	µg l^{-1}	0.2	<0.1	<0.1	1.5
Co	µg l^{-1}	2.8	<1.0	<1.0	2.2
Cr[C]	µg l^{-1}	1	<1.0	1.7	5.5
Cu[H]	µg l^{-1}	1.4	<1.0	2.3	11.1
Fe	mg l^{-1}	0.30	0.14	1.32	5.27
Mn	mg l^{-1}	1.70	0.02	0.23	0.94
Ni[H]	µg l^{-1}	11	<1.0	1.5	3.8
Pb[H]	µg l^{-1}	3.4	<1.0	1.1	7.1
Sb	µg l^{-1}	9	<1.0	<1.0	1.3
Se	µg l^{-1}	11	<1.0	<1.0	<1.0
V	µg l^{-1}	6	1.2	4.3	16.0
Zn[H]	µg l^{-1}	8	<1.0	2.4	32.5

Exceeded ANZECC Guideline (x1)	Exceeded ANZECC Guideline (x10)	Exceeded ANZECC Guideline (x100)

Notes.

The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).

** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity. Values outside the ranges defined in the ANZECC guidelines are indicated with yellow, orange and red background colours.*

[A] Guideline is for Aluminium in freshwater where pH > 6.5.

[B] Guideline assumes As in solution as Arsenic (AsV).

[C] Guideline for Chromium is applicable to Chromium (CrVI) only.

[H] Hardness affected (refer to Guidelines).

Table 8-43. Summary of contaminant and metalloid dynamics data for the Yarrein Creek.

Parameter	units	ANZECC Guidelines	Yarrein Creek channel samples	
			Min.	Max.
pH		6.5-8.0	7.04	7.69
EC*	$\mu S\ cm^{-1}$	125-2,200	2,205	6,275
Eh	mV	-	67	321
Ag	$\mu g\ l^{-1}$	0.05	<0.1	0.8
Al[A]	$mg\ l^{-1}$	0.055	<0.01	0.01
As[B]	$\mu g\ l^{-1}$	13	<1.0	5.6
Cd	$\mu g\ l^{-1}$	0.2	<0.1	<0.1
Co	$\mu g\ l^{-1}$	2.8	1.3	6.3
Cr[C]	$\mu g\ l^{-1}$	1	<1.0	1.5
Cu[H]	$\mu g\ l^{-1}$	1.4	2.3	4.3
Fe	$mg\ l^{-1}$	0.30	0.14	2.76
Mn	$mg\ l^{-1}$	1.70	2.13	13.53
Ni[H]	$\mu g\ l^{-1}$	11	2.2	6.8
Pb[H]	$\mu g\ l^{-1}$	3.4	<1.0	<1.0
Sb	$\mu g\ l^{-1}$	9	<1.0	<1.0
Se	$\mu g\ l^{-1}$	11	<1.0	5.9
V	$\mu g\ l^{-1}$	6	<1.0	<1.0
Zn[H]	$\mu g\ l^{-1}$	8	2.6	6.3

Exceeded ANZECC Guideline (x1)	***Exceeded ANZECC Guideline (x10)***	***Exceeded ANZECC Guideline (x100)***

Notes.

The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).

** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity. Values outside the ranges defined in the ANZECC guidelines are indicated with yellow, orange and red background colours.*

[A] Guideline is for Aluminium in freshwater where pH > 6.5.

[B] Guideline assumes As in solution as Arsenic (AsV).

[C] Guideline for Chromium is applicable to Chromium (CrVI) only.

[H] Hardness affected (refer to Guidelines).

Table 8-44. Summary of contaminant and metalloid dynamics data for the Wyam Creek.

Parameter	units	ANZECC Guidelines	Wyam Creek channel samples	
			Min.	Max.
pH		6.5-8.0	7.37	8.47
EC*	µS cm^{-1}	125-2,200	2,065	6,245
Eh	mV	-	96	261
Ag	µg l^{-1}	0.05	<0.1	1.0
Al[A]	mg l^{-1}	0.055	<0.01	<0.01
As[B]	µg l^{-1}	13	<1.0	4.4
Cd	µg l^{-1}	0.2	<0.1	<0.1
Co	µg l^{-1}	2.8	<1.0	<1.0
Cr[C]	µg l^{-1}	1	1.0	1.9
Cu[H]	µg l^{-1}	1.4	<1.0	<1.0
Fe	mg l^{-1}	0.30	0.13	0.40
Mn	mg l^{-1}	1.70	0.16	0.85
Ni[H]	µg l^{-1}	11	<1.0	1.0
Pb[H]	µg l^{-1}	3.4	<1.0	<1.0
Sb	µg l^{-1}	9	<1.0	1.3
Se	µg l^{-1}	11	<1.0	2.6
V	µg l^{-1}	6	<1.0	2.0
Zn[H]	µg l^{-1}	8	<1.0	5.1

Exceeded ANZECC Guideline (x1)	***Exceeded ANZECC Guideline (x10)***	***Exceeded ANZECC Guideline (x100)***

Notes.

The ANZECC guideline values for toxicants refer to the Ecosystem Protection – Freshwater Guideline for protection of 95% of biota in 'slightly-moderately disturbed' systems, as outlined in the Australian Water Quality Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).

** ANZECC water quality guidelines for lowland rivers in South-east Australia are provided for salinity. Values outside the ranges defined in the ANZECC guidelines are indicated with yellow, orange and red background colours.*

[A] *Guideline is for Aluminium in freshwater where pH > 6.5.*

[B] *Guideline assumes As in solution as Arsenic (AsV).*

[C] *Guideline for Chromium is applicable to Chromium (CrVI) only.*

[H] *Hardness affected (refer to Guidelines).*

APPENDIX 3. SUMMARY OF CHANNEL SYSTEM REACTIVE METALS DATA

Table 8-45. Summary of reactive metals data for the Edward-Wakool channel system (mg/kg dry wt.).

Parameter	ANZECC Sediment Quality Guidelines*		Reactive metals (mg/kg dry wt.)			% of Trigger value	
	SQG-Low (Trigger value)	SQG-High	Min.	Median	Max.	Min.	Max.
Ag	1	3.7	<0.001	0.002	0.012	<1%	1%
Al			51	283	778		
As	20	70	0.08	0.65	1.95	<1%	10%
Cd	1.5	10	<0.001	0.012	0.131	<1%	9%
Co			0.37	2.03	26.50		
Cr	80	370	0.04	0.20	0.71	<1%	<1%
Cu	65	270	0.29	3.46	6.19	<1%	10%
Fe			134	1,099	4,229		
Mn			14	137	11,246		
Ni	21	52	0.26	1.86	16.04	1%	76%
Pb	50	220	0.63	3.51	13.79	1%	28%
Sb	2	25	<0.001	0.005	0.021	<1%	1%
Se			<0.01	0.09	0.59		
V			0.73	5.68	14.47		
Zn	200	410	0.93	4.39	38.76	<1%	19%

** The ANZECC sediment quality guidelines (SQG) are for total metal concentrations (ANZECC/ARMCANZ 2000)*

Table 8-46. Summary of reactive metals data for the Wakool River (mg/kg dry wt.).

Parameter	ANZECC Sediment Quality Guidelines*		Reactive metals (mg/kg dry wt.)		% of Trigger value	
	SQG-Low (Trigger value)	SQG-High	Min.	Max.	Min.	Max.
Ag	1	3.7	0.001	0.004	<1%	<1%
Al			51	519		
As	20	70	0.08	1.05	<1%	5%
Cd	1.5	10	<0.001	0.073	<1%	5%
Co			0.37	5.99		
Cr	80	370	0.04	0.25	<1%	<1%
Cu	65	270	0.29	6.19	<1%	10%
Fe			134	2,983		
Mn			14	455		
Ni	21	52	0.26	8.06	1%	38%
Pb	50	220	0.63	13.79	1%	28%
Sb	2	25	0.001	0.020	<1%	1%
Se			<0.01	0.16		
V			0.73	14.47		
Zn	200	410	0.93	16.61	<1%	8%

** The ANZECC sediment quality guidelines (SQG) are for total metal concentrations (ANZECC/ARMCANZ 2000)*

Table 8-47. Summary of reactive metals data for the Niemur River (mg/kg dry wt.).

Parameter	ANZECC Sediment Quality Guidelines*		Reactive metals (mg/kg dry wt.)		% of Trigger value	
	SQG-Low (Trigger value)	SQG-High	Min.	Max.	Min.	Max.
Ag	1	3.7	0.001	0.001	<1%	<1%
Al			122	353		
As	20	70	0.34	0.99	2%	5%
Cd	1.5	10	0.006	0.010	<1%	<1%
Co			0.54	3.03		
Cr	80	370	0.15	0.25	<1%	<1%
Cu	65	270	1.12	4.03	2%	6%
Fe			464	1,448		
Mn			32	50		
Ni	21	52	0.60	1.37	3%	7%
Pb	50	220	1.45	4.78	3%	10%
Sb	2	25	0.001	0.008	<1%	<1%
Se			0.01	0.08		
V			4.46	8.67		
Zn	200	410	2.64	5.04	1%	3%

** The ANZECC sediment quality guidelines (SQG) are for total metal concentrations (ANZECC/ARMCANZ 2000)*

Table 8-48. Summary of reactive metals data for the Jimaringle Creek (mg/kg dry wt.).

Parameter	ANZECC Sediment Quality Guidelines*		Reactive metals (mg/kg dry wt.)		% of Trigger value	
	SQG-Low (Trigger value)	SQG-High	Min.	Max.	Min.	Max.
Ag	1	3.7	0.001	0.008	<1%	<1%
Al			449	568		
As	20	70	0.40	1.23	2%	6%
Cd	1.5	10	0.008	0.131	<1%	9%
Co			3.84	26.50		
Cr	80	370	0.15	0.38	<1%	<1%
Cu	65	270	3.57	4.42	5%	7%
Fe			1,837	4,229		
Mn			480	11,246		
Ni	21	52	2.76	16.04	13%	76%
Pb	50	220	1.51	3.64	3%	7%
Sb	2	25	0.007	0.010	<1%	<1%
Se			0.22	0.59		
V			2.25	7.78		
Zn	200	410	5.45	38.76	3%	19%

** The ANZECC sediment quality guidelines (SQG) are for total metal concentrations (ANZECC/ARMCANZ 2000)*

Table 8-49. Summary of reactive metals data for the Barbers Creek (mg/kg dry wt.).

Parameter	ANZECC Sediment Quality Guidelines*		Reactive metals (mg/kg dry wt.)		% of Trigger value	
	SQG-Low (Trigger value)	SQG-High	Min.	Max.	Min.	Max.
Ag	1	3.7	0.002	0.005	<1%	<1%
Al			218	231		
As	20	70	0.83	0.89	4%	4%
Cd	1.5	10	0.013	0.013	<1%	<1%
Co			1.95	2.73		
Cr	80	370	0.15	0.17	<1%	<1%
Cu	65	270	2.88	3.39	4%	5%
Fe			1,469	1,815		
Mn			142	149		
Ni	21	52	1.89	2.24	9%	11%
Pb	50	220	3.55	4.18	7%	8%
Sb	2	25	0.008	0.021	<1%	1%
Se			0.06	0.09		
V			4.62	5.96		
Zn	200	410	4.50	10.18	2%	5%

** The ANZECC sediment quality guidelines (SQG) are for total metal concentrations (ANZECC/ARMCANZ 2000)*

Table 8-50. Summary of reactive metals data for the Mallan Mallan Creek (mg/kg dry wt.).

Parameter	ANZECC Sediment Quality Guidelines*		Reactive metals (mg/kg dry wt.)		% of Trigger value	
	SQG-Low (Trigger value)	SQG-High	Min.	Max.	Min.	Max.
Ag	1	3.7	0.002	0.006	<1%	<1%
Al			317	538		
As	20	70	0.82	1.95	4%	10%
Cd	1.5	10	0.005	0.011	<1%	<1%
Co			1.37	2.94		
Cr	80	370	0.27	0.46	<1%	<1%
Cu	65	270	2.83	5.01	4%	8%
Fe			844	3,565		
Mn			140	656		
Ni	21	52	1.18	2.89	6%	14%
Pb	50	220	3.83	5.30	8%	11%
Sb	2	25	0.002	0.008	<1%	<1%
Se			0.25	0.37		
V			4.92	7.79		
Zn	200	410	2.08	3.48	1%	2%

** The ANZECC sediment quality guidelines (SQG) are for total metal concentrations (ANZECC/ARMCANZ 2000)*

Table 8-51. Summary of reactive metals data for the Merran Creek (mg/kg dry wt.).

Parameter	ANZECC Sediment Quality Guidelines*		Reactive metals (mg/kg dry wt.)		% of Trigger value	
	SQG-Low (Trigger value)	SQG-High	Min.	Max.	Min.	Max.
Ag	1	3.7	<0.001	0.002	<1%	<1%
Al			142	396		
As	20	70	0.40	0.71	2%	4%
Cd	1.5	10	0.006	0.018	<1%	1%
Co			0.98	3.86		
Cr	80	370	0.10	0.39	<1%	<1%
Cu	65	270	1.46	4.36	2%	7%
Fe			404	1989		
Mn			56	426		
Ni	21	52	1.06	3.43	5%	16%
Pb	50	220	2.00	4.01	4%	8%
Sb	2	25	0.004	0.016	<1%	<1%
Se			0.07	0.16		
V			4.20	9.47		
Zn	200	410	2.90	5.54	1%	3%

** The ANZECC sediment quality guidelines (SQG) are for total metal concentrations (ANZECC/ARMCANZ 2000)*

Table 8-52. Summary of reactive metals data for the Yarrein Creek (mg/kg dry wt.).

Parameter	ANZECC Sediment Quality Guidelines*		Reactive metals (mg/kg dry wt.)		% of Trigger value	
	SQG-Low (Trigger value)	SQG-High	Min.	Max.	Min.	Max.
Ag	1	3.7	0.007	0.012	<1%	1%
Al			701	778		
As	20	70	0.68	0.73	3%	4%
Cd	1.5	10	0.019	0.026	1%	2%
Co			6.33	6.50		
Cr	80	370	0.59	0.71	<1%	<1%
Cu	65	270	3.97	6.10	6%	9%
Fe			832	1,665		
Mn			874	1,063		
Ni	21	52	5.30	5.44	25%	26%
Pb	50	220	4.22	6.71	8%	13%
Sb	2	25	0.005	0.005	<1%	<1%
Se			0.40	0.51		
V			5.88	9.63		
Zn	200	410	4.80	6.55	2%	3%

** The ANZECC sediment quality guidelines (SQG) are for total metal concentrations (ANZECC/ARMCANZ 2000)*

Table 8-53. Summary of reactive metals data for the Wyam Creek (mg/kg dry wt.).

Parameter	ANZECC Sediment Quality Guidelines*		Reactive metals (mg/kg dry wt.)		% of Trigger value	
	SQG-Low (Trigger value)	SQG-High	Min.	Max.	Min.	Max.
Ag	1	3.7	<0.001	<0.001	<1%	<1%
Al			283	339		
As	20	70	0.41	0.52	2%	3%
Cd	1.5	10	0.014	0.021	<1%	1%
Co			1.72	2.49		
Cr	80	370	0.26	0.37	<1%	<1%
Cu	65	270	3.51	3.58	5%	6%
Fe			2,072	3,286		
Mn			904	1,876		
Ni	21	52	1.81	2.79	9%	13%
Pb	50	220	2.76	3.73	6%	7%
Sb	2	25	0.005	0.005	<1%	<1%
Se			0.22	0.54		
V			6.93	10.19		
Zn	200	410	3.83	5.39	2%	3%

** The ANZECC sediment quality guidelines (SQG) are for total metal concentrations (ANZECC/ARMCANZ 2000)*