# Assessment of the quality of water samples collected from Wingecarribee River on 26/09/19 (Project 20190111)

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**5 November 2019**

**Summary**

The water samples collected in September 2019 from the Wingecarribee River upstream of the adit discharge (Upstream) and approximately 150m downstream of the adit discharge (Downstream) were not chronically toxic to the standard laboratory test organisms, the cladoceran *Ceriodaphnia dubia* and the alga *Raphidocelis subcapitata* (formerly known as *Pseudokirchneriella subcapitata*). They were also not acutely toxic to *C. dubia* and the larval rainbowfish *Melanotaenia douboulayi*.

A comparison of the chemical analyses results revealed that the conductivity, alkalinity, dissolved organic carbon and concentrations of the nutrients, anions, and metals were all consistent between the Upstream and the Downstream sampling sites.

A comparison of the chemical analyses results for the Downstream sample with those collected from the same location in December 2017 (OEH 2018a) and April 2018 (OEH 2018b) showed that concentrations of trace metals and major ions had decreased. In the current sampling event, no metals exceeded the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2019) for 95% level of protection where available.

## Introduction

On 27 September 2019, two samples collected from Wingecarribee River relating to discharges from the Berrima Colliery were received by the Department of Planning, Industry and Environment (DPIE) Environmental Forensics (EF) Team for assessment of analytical and toxicological quality. This report presents a summary of the chemical analyses and toxicity testing performed and compares them to the results of two previous sampling events, in December 2017 (OEH 2018a) and April 2018 (OEH 2018b). Full chemical analyses and toxicity test results are presented in the EF Report of Analysis 20190111.

## Experimental

Water samples from Wingecarribee River (Table 1) were chemically analysed by the EF Chemical Forensics Team and an external laboratory (for nutrients) using standard methods with NATA accreditation for compliance with ISO 17025. Analytes tested were:

- alkalinity
- dissolved organic carbon (DOC)
- metals (acid-extractable & lab-filtered (0.45 µm))
- nutrients (ammonia, nitrates + nitrites (NOx), total nitrogen, total phosphorus, and reactive phosphorus)
- major anions (bromide, chloride, fluoride, and sulfate).

Dissolved oxygen, electrical conductivity, pH and temperature were measured in the field by Megan Gillmore from the Department of Planning, Industry and Environment (data not presented).

In addition, the EF Ecotoxicology Team performed toxicity testing on the samples using a range of species and endpoints:

- 7-d cladoceran *C. dubia* immobilisation and reproduction impairment (chronic)
- 72-h alga *R. subcapitata* growth inhibition (chronic)
- 48-h cladoceran *C. dubia* immobilisation (acute) and
- 48-h larval rainbowfish *M. duboulayi* imbalance (acute).

**Table 1. Environment Protection Authority (EPA) sampling site descriptions and corresponding EF sample numbers**

| EPA sampling site description | EF Sample number | Sample ID |
|---|---|---|
| Upstream of adit discharge | 190750 | Upstream |
| Approximately 150 m downstream of adit discharge | 190751 | Downstream |

## Results and discussion

### *Toxicity tests*

Appendix Table A presents the results of toxicity testing of the water samples. In summary, both the Upstream sample and the Downstream sample were found to be not toxic to any of the species or endpoints investigated. The microalgal growth inhibition test with *R. subcapitata* indicated stimulation of algal growth relative to the control. The stimulation observed was consistent between the Upstream and Downstream samples and was most likely due to slightly elevated nitrogen present in both samples.

### *Chemical analysis*

Appendix Table B presents a summary of the chemical analyses of the water samples. The metals considered 'major metals' are grouped with those that are typically of higher concentrations compared to the second group that are typically considered 'trace metals'. Both the acid-extractable and lab-filtered (or dissolved metal concentrations) are included in Appendix Table B. A comparison between these two data for a metal gives an indication of size speciation (i.e. soluble vs insoluble or 'associated with particulate').

Results tabulated in Appendix Table B show that:

- Electrical conductivity, total alkalinity, DOC, nutrients and the levels of the major cations and anions were consistent (less than 10% difference) between the Upstream and Downstream samples.
- Except for aluminium, the acid-extractable and lab-filtered results for all major metals were consistent (less than 10% difference). The results were also consistent (less than 10% difference) between the Upstream and Downstream samples. The results indicate that aluminium was mostly present in an insoluble form or associated with particulates.
- For all trace metals, there was no difference between the acid-extractable and lab-filtered values. There was also no difference in the trace metal concentrations between the Upstream and Downstream samples. All trace metal concentrations were low or below the limit of detection of the instrument.

Appendix Table C compares the concentration of key analytes of interest, identified through previous sampling events, December 2017 (OEH 2018a) and April 2018 (OEH 2018b), with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2019) for 95% level of protection where available.

Results tabulated in Appendix Table C show that:

- Concentrations of the dissolved metals cobalt, nickel, manganese and zinc in both

the upstream and downstream samples measured in the current sampling event were lower than those measured in December 2017 and April 2018.

- Levels of the trace metals cobalt, nickel and zinc previously exceeded their corresponding ANZG (2019) Default Guideline Value (DGV) in the Downstream sample for both the December 2017 and April 2018 sampling events. No dissolved metal concentrations from the current sampling event exceeded their corresponding ANZG (2019) DGV where available.
- In the current sampling event the concentrations of calcium, magnesium, manganese and strontium were consistent (less than 10% difference) in both the Upstream and Downstream samples. Previously elevated calcium, magnesium, manganese and strontium were measured in the Downstream sample compared to the Upstream sample in December 2017 and April 2018 sampling events.

**References**


1. ANZG 2019. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments. Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines

2. OEH 2018a. Office of Environment and Heritage – Assessment of the quality of water samples collected from Wingecarribee River on 13/12/17 (Project 201700537). February 2018.

3. OEH 2018b. Office of Environment and Heritage – Assessment of the quality of water samples collected from Wingecarribee River on 18/04/18 (Project 201800158). May 2018.

**Appendix Table A. Summary of toxicity test results**

| Toxicity test species (endpoint) | **Upstream** | **Downstream** |
|---|---|---|
| Cladoceran *C. dubia* (immobilisation/ reproduction impairment) | Effects on survival and reproduction were not significantly different to those in the control dilution water | Effects on survival and reproduction were not significantly different to those in the control dilution water |
| Alga *P. subcapitata* (growth inhibition) | Not chronically toxic | Not chronically toxic |
| 48-h cladoceran C. dubia (immobilisation) | Not acutely toxic | Not acutely toxic |
| Larval rainbowfish *M. duboulayi* (imbalance) | Not acutely toxic | Not acutely toxic |

**Appendix Table B. Summary of chemical analyses results**

| | | 190750 - Upstream | | 190751 - Downstream | |
|---|---|---|---|---|---|
| Electrical conductivity | µS/cm | 280 | | 280 | |
| Total alkalinity | mg/L CaCO3 | 40 | | 39 | |
| Dissolved Organic Carbon | mg/L | 4 | | 4 | |
| ***Nutrients*** | | | | | |
| Ammonia-N | mg/L | 0.01 | | <0.01 | |
| NOx-N | mg/L | 0.90 | | 0.85 | |
| Total N | mg/L | 1.3 | | 1.2 | |
| Total P | mg/L | <0.01 | | 0.02 | |
| Reactive Phosphorus-P | mg/L | <0.01 | | <0.01 | |
| ***Anions*** | | | | | |
| Bromide | mg/L | <0.5 | | <0.5 | |
| Chloride | mg/L | 35 | | 35 | |
| Fluoride | mg/L | <0.3 | | <0.3 | |
| **Sulfate** | **mg/L** | **28** | | **31** | |
| ***Metals*** | | **Acid -extractable** | **Lab filtered** | **Acid -extractable** | **Lab filtered** |
| Aluminium Al | mg/L | 0.39 | <0.04 | 0.36 | <0.04 |
| Boron B | mg/L | <0.1 | <0.1 | <0.1 | <0.1 |
| Calcium Ca | mg/L | 13 | 13 | 13 | 13 |
| Magnesium Mg | mg/L | 5.6 | 5.3 | 6.0 | 5.9 |
| Manganese Mn | mg/L | 0.02 | <0.02 | 0.05 | <0.02 |
| Phosphorus P | mg/L | <0.04 | <0.04 | <0.04 | <0.04 |
| Potassium K | mg/L | 7.3 | 7.2 | 7.2 | 7.1 |
| Sodium Na | mg/L | 27 | 26 | 27 | 26 |
| Strontium Sr | mg/L | 0.05 | 0.05 | 0.06 | 0.06 |
| Sulfur S | mg/L | 10 | 10 | 11 | 12 |
| Titanium Ti | mg/L | <0.01 | <0.01 | <0.01 | <0.01 |
| Antimony Sb | mg/L | <0.02 | <0.02 | <0.02 | <0.02 |
| Arsenic As | mg/L | <0.03 | <0.03 | <0.03 | <0.03 |
| Barium Ba | mg/L | 0.03 | 0.03 | 0.03 | 0.03 |
| Beryllium Be | mg/L | <0.01 | <0.01 | <0.01 | <0.01 |
| Cadmium Cd | mg/L | <0.01 | <0.01 | <0.01 | <0.01 |
| Chromium Cr | mg/L | <0.01 | <0.01 | <0.01 | <0.01 |
| Cobalt Co | mg/L | <0.01 | <0.01 | <0.01 | <0.01 |
| Copper Cu | mg/L | <0.03 | <0.03 | <0.03 | <0.03 |
| Lead Pb | mg/L | <0.02 | <0.02 | <0.02 | <0.02 |
| Lithium Li | mg/L | <0.01 | <0.01 | <0.01 | <0.01 |
| Molybdenum Mo | mg/L | <0.01 | <0.01 | <0.01 | <0.01 |
| Nickel Ni | mg/L | <0.02 | <0.02 | <0.02 | <0.02 |
| Selenium Se | mg/L | <0.04 | <0.04 | <0.04 | <0.04 |
| Silver Ag | mg/L | <0.006 | <0.006 | <0.006 | <0.006 |
| Thallium Tl | mg/L | <0.01 | <0.01 | <0.01 | <0.01 |
| Tin Sn | mg/L | <0.02 | <0.02 | <0.02 | <0.02 |
| Vanadium V | mg/L | <0.01 | <0.01 | <0.01 | <0.01 |
| Zinc Zn | mg/L | <0.03 | <0.03 | <0.03 | <0.03 |

**Appendix Table C. Comparison between contaminant concentrations in water samples from Wingecarribee River in September 2019, April 2018 and December 2017**

| | Water Quality DGV[1] | 26 September 2019 sampling | | 18 April 2018 sampling | | 13 December 2017 sampling | |
|---|---|---|---|---|---|---|---|
| | | Upstream | Downstream | Upstream | Downstream | Upstream | Downstream |
| Electrical conductivity, EC (µS/cm) | 125 - 2200 | 280 | 280 | 310 | 530 | 300 | 540 |
| **Dissolved metals (mg/L)** | | | | | | | |
| Calcium Ca | - | 13 | 13 | 13 | 26 | 12 | 28 |
| Magnesium Mg | - | 5.3 | 5.9 | 7.1 | 24 | 6.5 | 23 |
| Manganese Mn | 1.9 | <0.02 | <0.02 | 0.003 | 1.6 | 0.002 | **3.0** |
| Strontium Sr | - | 0.05 | 0.06 | 0.08 | 0.12 | 0.078 | 0.13 |
| Sulfur S | - | 10 | 12 | 7.9 | 37 | 6.8 | 40 |
| Cobalt Co | 0.0014 | <0.01 | <0.01 | 0.0001 | **0.017** | <0.0001 | **0.035** |
| Nickel Ni | 0.011 | <0.02 | <0.02 | 0.0023 | **0.063** | 0.0009 | **0.099** |
| Zinc Zn (mg/L) | 0.008 | <0.03 | <0.03 | 0.005 | **0.060** | <0.001 | **0.058** |

[1] Default guideline value for the protection of 95% of species for metals (ANZG 2019). Concentrations that exceed their respective guideline are identified in **bold**.