Annual Water Quality Monitoring Report

2023-24

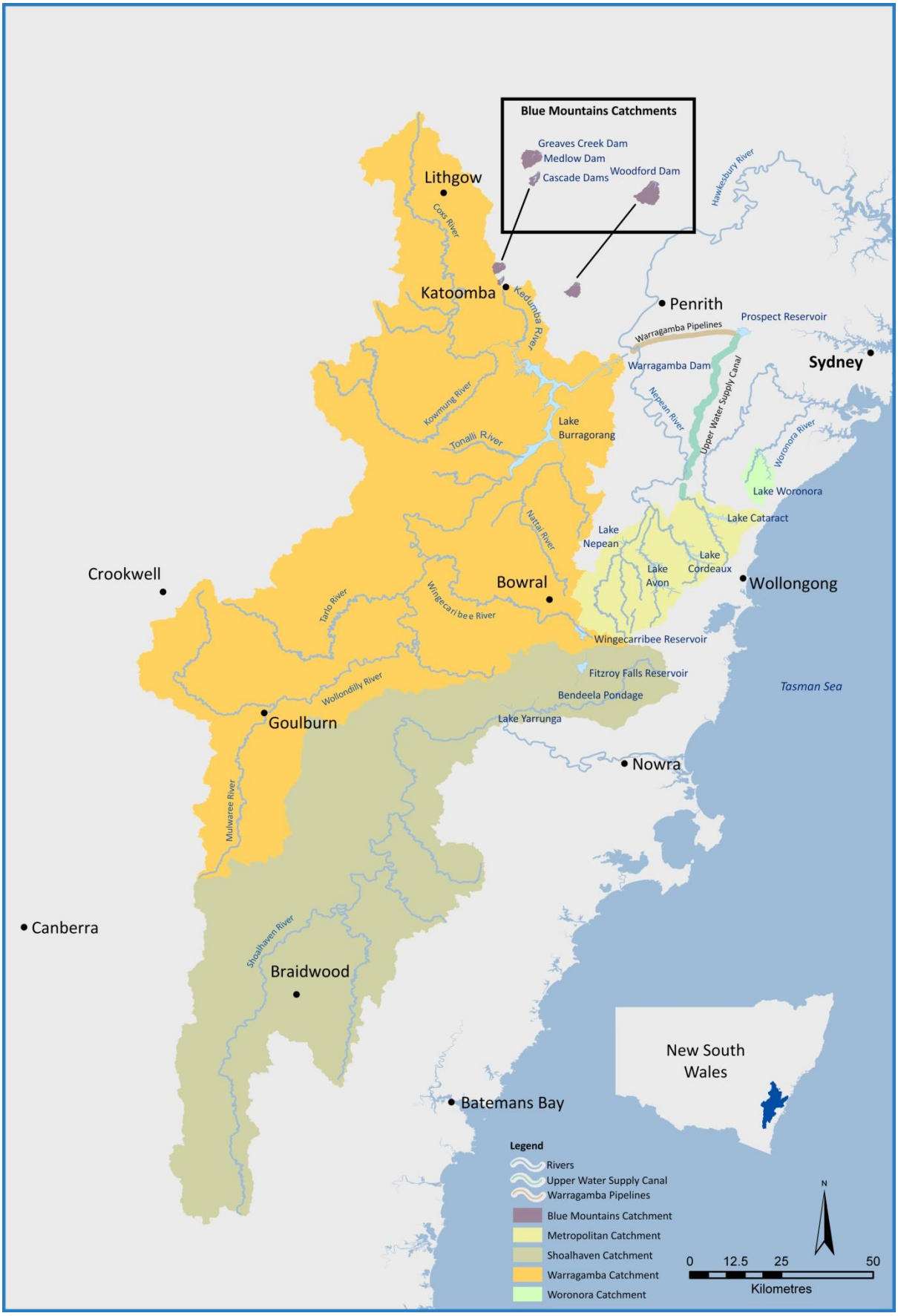

Figure 0.1: Sydney catchment area

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Front Cover: Warragamba Dam. 2024. Copyright WaterNSW.

Executive Summary

WaterNSW's Water Monitoring Program (WMP) for the Sydney catchment area details the comprehensive monitoring activities covering catchments, lakes, intakes to water filtration plants, picnic areas and downstream river sites. The WMP has been developed in collaboration with NSW Health, Sydney Water and councils. The program incorporates locations, frequency and benchmarks or guideline values for more than 200 water quality characteristics. The WMP includes routine and event monitoring employing field sampling, laboratory testing and telemetered 'real-time' data collection from in-situ instruments. Monitoring provides timely water quality data and information to inform water quality risks, operational decisions and verification of water quality to demonstrate compliance.

This report describes the results of the water quality monitoring undertaken by WaterNSW during 2023-24. The report is prepared to meet WaterNSW's statutory obligations and supports the implementation of WaterNSW' Water Quality Management System, providing valuable information for the assessment of water quality changes and early identification of potential threats to water quality. This allows WaterNSW to proactively develop mitigation strategies, required for the protection of our water sources and water supplied for treatment. In addition, it provides stakeholders, students, researchers and the general public with water quality information for waters managed by WaterNSW in the greater Sydney catchment area.

Highlights

The 2023-24 reporting period commenced with a total storage volume of 93.2% on the 1st of July 2023. Minimal inflows were received in the following 6 months, providing a period of relative stability for water quality, with gradual improvements recorded across many analytes. The overall storage volume reached a minimum for the reporting period of 87.3% on the 19th of December 2023.

Minor inflows during the first quarter of 2024 led to gradual increases in storage volumes across Greater Sydney, with only minimal changes in water quality. The Greater Sydney catchments were then hit by three wet weather events in quick succession. An intense rainfall event in early April, a prolonged event of lower intensity in early May, followed by another intense event in early June. Spills were recorded across multiple storages for all three events. The cumulative impact of these events significantly affected water quality, leading to higher levels of turbidity, organics, and metals across Greater Sydney's storages. An incident management team was established to manage flood operations in April and again in June 2024. Despite these significant challenges, through proactive modelling, monitoring and source selection, WaterNSW continued to deliver best available source water to our customers to ensure safety of the water supply was not compromised. Total storage volume ended the reporting period at 97.6% on the 30th of June 2024.

Guided by its Water Quality Management System, WaterNSW successfully delivered agreed quantities of high quality water to customers in full compliance with the Australian Drinking Water Guidelines (ADWG) for health-related characteristics.

Water supplied to **water filtration plants** achieved 99.05% compliance with site specific standards in raw water supply agreements. Exceptions included turbidity, aluminium and total hardness which were all related to wet weather inflow events. Other exceptions related to natural processes in waterways included algal ASU (a measure of filter clogging potential), total iron and alkalinity. These issues were highlighted to customers and were managed in accordance with the Water Quality Incident Response Protocol.

WaterNSW continued to manage **picnic area supply** sites in accordance with the Quality Assurance Plans developed in line with NSW Private Water Supply Guidelines. Similar to the previous year, poor source water quality was a challenge due to rain events particularly at Cataract and Cordeaux. This resulted in periods where potable water could not be supplied, with picnic area taps signposted as not suitable for drinking. The efficacy of chlorine disinfection was demonstrated based on chlorine residuals and chlorine contact times achieved at the dosing plant, and the absence of *E. coli* and indicator bacteria in the supplies. Noting however that there was a single sample from Fitzroy Falls with a low level detection of E. coli, however, follow up sampling did not identify any issues with the supply.

Water quality in the Greater Sydney **catchments** displayed similar patterns to previous years. Highly protected, natural bushland catchments continue to outperform catchments dominated by agricultural and urban land uses, predominantly for nutrients. Rainfall also had an impact on catchment water quality with heavy rainfall events in April, May and June 2024 causing an increase in ANZECC benchmark exceedances, particularly for aluminium.

Water quality in 2023-24 achieved
99.05% conformance with Raw Water Supply Agreements and
100% conformance with Australian Drinking Water Guidelines

Monitoring **downstream** of WaterNSW storages is part of the requirements of the Water Licences and Approvals package administered by the Natural Resources Access Regulator. Similar patterns to 2022-2023 were observed across all downstream of storage sites. In the Nepean River system water quality remains poorer moving downstream due to uncontrolled catchment influences.

WaterNSW successfully managed seventeen major water quality incidents as triggered by and in accordance with our Water Quality Incident Response Protocol, including impacts from wet weather events and algal blooms.

Investigative monitoring was undertaken to determine the origin of elevated concentrations of geosmin (a taste and odour compound) that were detected in Lake Burragorang in August 2023. Genetic material from geosmin-producing *Dolichospermum sp.* was confirmed by

molecular analysis in samples collected from Lake Burragorang. Another study is underway to investigate the impact of wildfires and hazard reduction burns on water quality in drinking water catchments. Ash samples collected from WaterNSW special areas are being analysed for a range of physical and chemical parameters to identify changing trends in water quality following fires.

The annual **Macroinvertebrate Monitoring Program** scored 86 routine sites against the AUSRIVAS band grades in 2023. Of the 79 sites monitored in both 2022 and 2023, 76 received a higher AUSRIVAS score in 2023, while 3 recorded lower values. This indicates a strong recovery in macroinvertebrate health across the declared catchment; with 31 sites improving by one or more band grades. This recovery is likely to have been influenced by more stable climatic conditions, with drier conditions experienced across the Sydney Drinking Water Catchment in the spring 2023 sampling season when compared to the higher rainfall and streamflow conditions observed in 2022.

1 Introduction

WaterNSW is a state-owned corporation whose responsibilities include, inter-alia, supplying water in compliance with appropriate standards of quality (Section 6(1)(b), Water NSW Act 2014) in the Sydney catchment area. WaterNSW undertakes extensive monitoring within its catchments, lakes and raw water supply system and in rivers downstream of storages to meet this objective.

WaterNSW's Water Monitoring Program (WMP) sets out the location, frequency and analytes monitored for the Sydney catchment area and the regional area (WaterNSW, 2021). Specific and health-related characteristics are determined in consultation with our major customers and the program is developed to the satisfaction of NSW Health. Monitoring for operations and planning helps WaterNSW understand the threats to water quality throughout the supply system, including rivers, lakes and the delivery system. This information aids the selection of the best source water for our customers and the environment.

Data collected through the WMP is used to:

- provide early detection of possible contaminants to protect the health of consumers
- assist in proactive operational decisions
- ensure that the raw water delivered to our customers meets agreed standards and can be treated to meet the Australian Drinking Water Guidelines
- identify and target possible contamination sources in the catchments and storages
- prioritise monitoring to inform water quality risks and remedial actions
- identify emerging water quality issues and address them in forward configurational planning

WaterNSW's compliance monitoring activities are governed by the following key drivers:

- Operating Licence and Reporting Manual granted by the Governor of NSW and administered by Independent Pricing and Regulatory Tribunal (IPART)
- Water Licences and Approvals package granted by the Water Administration Ministerial Corporation and administered by the Department of Climate Change, Energy, the Environment and Water (DCCEEW)
- Raw water supply agreements between WaterNSW and its customers
- Australian Drinking Water Guidelines
- NSW Private Water Supply Guidelines and Public Health Act 2010
- ANZECC benchmarks

This report describes the results of water quality monitoring undertaken by WaterNSW in the Sydney catchment area between 1 July 2023 and 30 June 2024 under the WMP. The report is a requirement of the Reporting Manual of the Operating Licence. The report also provides the community with information on water quality.

More specifically this report includes:

- a summary of the WMP, including objectives and applicable guidelines
- a summary of the results of the routine, event and investigative monitoring
- analysis of system performance relative to the criteria where relevant water quality or catchment health benchmarks are available
- information on the integrity of the data reported
- details of research activities
- summary of water quality incidents and actions taken to resolve, eliminate or mitigate the effect of those incidents, especially to protect public health during the incident.

2 Overview of the Sydney catchment area water supply network

WaterNSW collects water from river catchments to the south and west of Sydney and stores it in lakes and reservoirs to supply more than five million people in the Greater Sydney region.

It is transported via a network of rivers, lakes, pipes and canals to water filtration plants, where it is treated for consumers in Sydney, Illawarra, Shoalhaven, Goulburn, Blue Mountains and the Southern Highlands. Water is also released from storages as environmental flows to maintain the health of the downstream river systems.

The catchments cover an area of approximately 16,000 square kilometres, extending from the headwaters of the Coxs River north of Lithgow, south to the source of the Shoalhaven River near Cooma, and from Woronora in the east to the Wollondilly River near Crookwell in the west (Figure 0.1). Raw water is collected from the river systems of five major catchments:

- Warragamba (including Prospect)
- Upper Nepean
- Woronora
- Shoalhaven
- Blue Mountains, including supplementary flows from the Fish River system.

The transfer routes for water around the system and approximate number of people supplied by that part of the system are shown in the water supply system schematic (Figure 2.1).

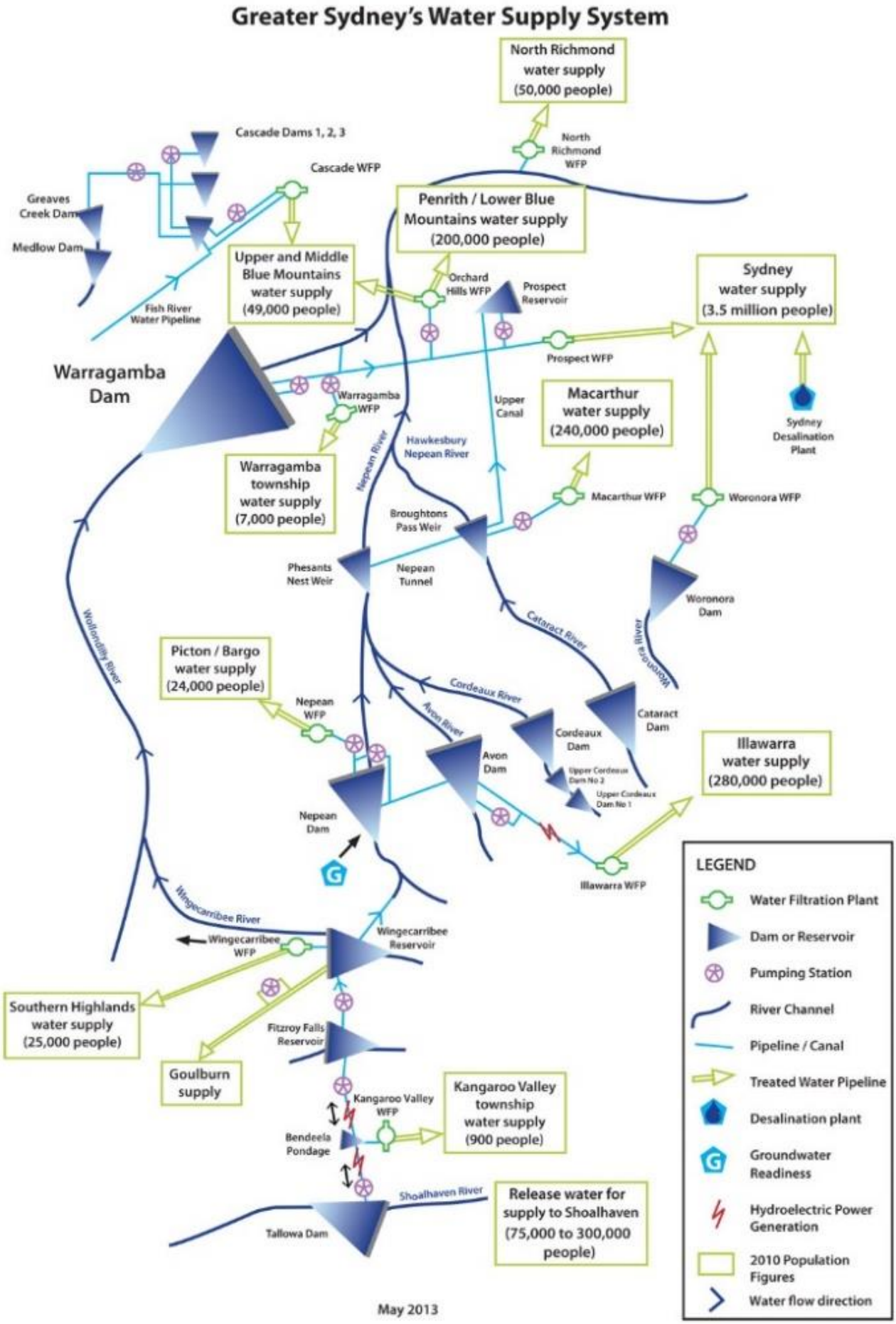

Figure 2.1: Schematic of the water supply system

3 Sydney catchment area water monitoring program

The Water Monitoring Program (WMP) consists of operational, verification and investigative monitoring. The WMP covers catchments, storages, inlets to water filtration plants, picnic taps, transfer canals and pipelines, as well as rivers downstream of water supply dams and weirs. Monitoring includes physical, chemical, biological, radiological, hydrological and meteorological parameters through on-line instruments, field sampling and laboratory analysis. A key feature of the WMP is an agreed list of water quality characteristics. The list contains:

- those characteristics that cannot be managed by conventional treatment and for which Australian Drinking Water Guidelines (ADWG) must be met; and,
- those characteristics for which ADWG exist but are not applicable to raw water, where WaterNSW must endeavour to supply raw water so that it can be treated to meet the ADWG.

WaterNSW is subject to a range of statutory requirements and standards set by regulatory agencies. WaterNSW is also benchmarked against other raw water suppliers to maintain best practice service standards.

The principal instruments and documents that outline requirements on WaterNSW with respect to water monitoring are listed below:

- *Water NSW Act 2014*.
- Operating Licence (Part 2), *Water NSW Act 2014* (Division 4)
- Water Licences and Approvals Package under Water Management Act 2000
- Memorandum of Understanding between NSW Health and WaterNSW (2022) (Parts 5-8)
- Raw Water Supply Arrangements
- Water Quality Incident Response Protocol
- Private Water Supply Guidelines and *Public Health Act 2010*
- *Water Act 2007* (Commonwealth)

The WMP specifies the requirements for water sample collection and analysis. It describes sampling locations and frequencies, and the parameters to be analysed. Additional samples are collected and analysed for quality assurance and quality control (QA/QC) purposes and during events. The QA/QC program provides confidence in the data collected.

The collection and analysis of routine and QA/QC water samples is performed by WaterNSW monitoring staff and external service providers. Service contracts include requirements for quality assurance practices in the monitoring, sampling, testing and reporting processes. A chain of custody system allows individual samples to be tracked from field collection, through laboratory analysis, to the transfer of results to WaterNSW's database. Further details of the QA/QC monitoring for 2023-24 are included in Section 5.1.

4 Applicable guidelines and benchmarks

WaterNSW has adopted nationally recognised standards and guidelines for a range of water quality characteristics in each part of the water supply network. Different guidelines and standards apply to each part of the supply cycle as water passes from catchment waterways into lakes and then into the delivery network or downstream rivers.

4.1 Australian Drinking Water Guidelines (ADWG)

The Australian Drinking Water Guidelines (NHMRC, 2011 and later revisions) apply to any water intended for drinking, irrespective of the source or where it is consumed. The ADWG framework for managing drinking water quality advocates risk management and preventive measures at all barriers from catchment to consumer.

For water quality characteristics that have been specified as 'health related', including metals, pesticides and synthetic organic compounds (Table 4.1a-b), raw water must conform to the ADWG. As conventional water treatment methods are not designed to remove these compounds from raw water, it is preferable to avoid them in the raw water supply through catchment and storage management practices. Drinking water supply at picnic areas is managed in accordance with the ADWG.

Routine monitoring of radionuclides is performed at water filtration plants by screening for gross alpha and gross beta activity concentrations. Testing for individual radionuclides is performed in the case of a positive gross alpha or gross beta result. Gross alpha and gross beta screening is now carried out three-yearly in accordance with ADWG. Gross alpha and gross beta screening was not conducted in this reporting period.

4.2 Raw water supply agreements

WaterNSW has established terms and conditions of supply with wholesale customers to ensure treated water is not harmful to consumers' health. WaterNSW maintains raw water supply agreements with Sydney Water, Wingecarribee Shire Council, Goulburn Mulwaree Council and Shoalhaven City Council. Raw water supplied for treatment is required to conform to site-specific standards specified in raw water supply agreements (Table 4.3). These standards are based on the treatment capabilities of the plants and the natural characteristics of the catchment. This ensures that raw water can be treated to meet ADWG requirements.

Table 4.1a: Health-related water quality characteristics: Synthetic Organics, Radiological and Pesticide Characteristics

	SPECIFIC WATER CHARACTERISTIC	DRIVER	ADWG (2011) Health Guideline
SYNTHETIC ORGANICS - RADIOLOGICAL - PESTICIDES	**Synthetic Organic Compounds**	Operating Licence[1]	
	Benzene		0.001 mg/L
	Vinyl chloride		0.0003 mg/L
	Pesticides		
	2,4-D (2,4-Dichlorophenoxyacetic acid)		0.03 mg/L
	Atrazine		0.02 mg/L
	Chlorfenvinphos		0.002 mg/L
	Chlorpyrifos		0.01 mg/L
	Diuron		0.02 mg/L
	Flupropanate		0.009 mg/L
	Glyphosate		1.0 mg/L
	Hexazinone		0.4 mg/L
	MCPA (2-methyl-4-clorophenoxyacetic acid)		0.04 mg/L
	Picloram		0.3 mg/L
	Simazine		0.02 mg/L
	Triclopyr		0.02 mg/L
	Radiological	ADWG recommends screening level test for radiological parameters	
	Gross alpha		0.5 Bq/L
	Gross beta		0.5 Bq/L

1 Section shaded yellow contains health related water quality characteristics. These characteristics must not exceed Australian Drinking Water Guidelines (NHMRC, 2011) in raw water supplied as treatment may not remove them. Minimising these in raw water effectively minimises risk to consumers.

Table 4.2b: Health-related and aesthetic Water Quality Characteristics: (Physical, Chemical, Biological and Organic)

	SPECIFIC WATER CHARACTERISTIC	DRIVER	Guideline
PHYSICAL - CHEMICAL - BIOLOGICAL - ORGANIC	Arsenic Barium Beryllium Boron Iodide Manganese Mercury Molybdenum Selenium Silver Tin	ADWG (2011)[1] Health Guideline	0.01mg/L 2 mg/L 0.06mg/L 4 mg/L 0.5 mg/L 0.5 mg/L 0.001 mg/L 0.05 mg/L 0.01 mg/L 0.1 mg/L N/A
	Antimony Cadmium Chromium (Cr^{VI}) Copper Fluoride Lead Nickel Nitrate Nitrite	ADWG (2011)[2] Health Guideline (NSW Private Water Supply Guidelines, 2016)	0.003 mg/L 0.002 mg/L 0.05 mg/L 2 mg/L 1.5 mg/L 0.01 mg/L 0.02 mg/L 50 mg/L 3 mg/L
	E. coli Enterococci *C. perfringens* *Cryptosporidium* *Giardia* Toxin producing cyanobacteria Toxicity Total cyanobacteria biovolume	ADWG (2011) Operating Licence[3]	Seek advice from NSW Health
	Algae (ASU) Alkalinity Aluminium Hardness Iron Manganese Odour pH True colour Turbidity	Water Supply Agreements	Refer to Water Supply Agreements
	Total cyanobacteria biovolume Total toxin producing cyanobacteria Toxicity Enterococci	Water Licences and Approvals Package (WLAP)[4]	Refer to *Guidelines for Managing Risks in Recreational Water* (NHMRC 2008)

1 Section shaded **yellow** contains health related water quality characteristics – these characteristics must not exceed Australian Drinking Water Guidelines (NHMRC, 2011) in treated waters or in raw water supplied as treatment may not remove them. Minimising these in raw water effectively minimises risk to consumers.

2 Section shaded **orange** contains health related water quality characteristics for private water supplies – these characteristics must not exceed Australian Drinking Water Guidelines (NHMRC, 2011) in treated waters.

3 Section shaded **blue** contains characteristics for which drinking water guidelines exist but these are not applicable for raw water. However, WaterNSW must endeavour to supply the best quality raw water available so that it can be treated to meet Australian Drinking Water Guidelines.

4 Section shaded **green** contains characteristics which apply for recreational waters and releases.

Table 4.3: Raw water supply agreements – Site specific standards

		Turbidity	True Colour @400 nm	Iron	Manganese	Aluminium	Hardness	Alkalinity	pH	Odour	Algae
		NTU	CU	mg/L	mg/L	mg/L	mg/L as CaCO3	mg/L as CaCO3	pH units	Rating	ASU
Prospect WFP		40	60	3.50	1.40	2.6	25 – 70	15 - 60	NA	NA	1000[i]
Warragamba WFP											2000
Orchard Hills WFP											
Macarthur WFP Based on Demand (ML/day)	185 - <265	10	40	0.60	0.20	0.40	6 – 30	15			100[ii]
	125 - <185	25		0.80	0.25	0.50	6 – 32.20				
	80 - <125	50		1.10	0.30	0.75					500[ii]
	<80	60		1.30	0.35	0.95					
Illawarra WFP		10	50	1.1	0.4	1.4	30	10		Not objectionable	5000
Woronora WFP			70	1	0.1	0.4	2 – 30	15			
Nepean WFP		150	60	5.0	1.5	1.0	2 – 35	0.5 – 25		NA	2000
Cascade WFP		15		3.0	0.3	0.2	40	30			
Kangaroo Valley WFP		20	70	1.1	0.4	NA	36.5	29	6.5 – 8.5		5000
Wingecarribee WFP		40			NA			35			
Goulburn Mulwaree											

(i) Maximum for Prospect WFP is 1000 ASU, except if turbidity is greater than 10 NTU or true colour is greater than 30 CU, then the algae maximum will be 500 ASU.

(ii) Algal limits for Macarthur WFP (average of 3 samples): 500 ASU small individual cells (<10 µm) of filamentous or colonial species, typically *Chlorella*, *Dolichospermum*, *Monodus* and *Melosira*; or 100 ASU large (>10 µm) cells, branching species, and/or gelatinous species, typically *Asterionella*, *Taballaria, Fragillaria, Synedra, Cyclotella, Dinobryan, Elakatothrix*, and *Volvox*.

(iii) Upper limits are shown for analytes where ranges are not provided.

4.3 ANZECC 2018

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018) (ANZECC, 2018) provide a guide for setting water quality objectives required to sustain current or likely future environmental values for natural and semi-natural water resources in Australia and New Zealand. Water quality in WaterNSW Sydney catchment area waterways is compared against relevant sections of the ANZECC Guidelines.

Benchmarks for storages

Benchmarks for storages are derived from the guidelines for freshwater lakes and reservoirs (ANZECC, 2018) for the 95-99 percent level of species protection (Table 4.4). Site specific benchmarks are to be developed for temperature and conductivity, and as such are not included in the table below.

Table 4.4: Water quality benchmarks for storages

Analyte	Units	Benchmark range
pH	pH units	6.5 - 8.0
Chlorophyll *a*	µg/L	< 5
Dissolved oxygen	% sat	90 – 110
Total nitrogen	mg/L	< 0.35
Oxidised nitrogen	mg/L	< 0.01
Ammoniacal nitrogen	mg/L	< 0.01
Total phosphorus	mg/L	< 0.01
Filterable reactive phosphorus	mg/L	< 0.005
Turbidity	NTU	< 20.0
Total manganese	mg/L	< 1.9
Total aluminium	mg/L	< 0.055

Benchmarks for catchments

WaterNSW benchmarks water quality in metropolitan catchment streams against the ANZECC (2018) guideline ranges for upland rivers (Table 4.5).

Table 4.5: Water quality benchmarks for catchment streams

Analyte	Units	Benchmark range
pH	pH units	6.5 – 8.0
Chlorophyll *a*	µg/L	< 5
Dissolved oxygen	% sat	90 – 110
Total nitrogen	mg/L	< 0.25
Ammoniacal nitrogen	mg/L	< 0.013
Oxidised nitrogen	mg/L	< 0.015
Total phosphorus	mg/L	< 0.02
Filterable reactive phosphorus	mg/L	< 0.015
Turbidity	NTU	< 25
Total aluminium	mg/L	< 0.055
Total manganese	mg/L	< 1.9
Conductivity	mS/cm	< 0.35

4.4 Benchmarks for recreational areas

To minimise risks to public health, WaterNSW manages recreational exposure risk by benchmarking water quality against the Guidelines for Managing Risks in Recreational Waters (NHMRC, 2008) (Table 4.5).

Table 4.6: Water quality benchmarks for recreation areas

Analyte	Units	Primary Contact		Secondary Contact
		Minor Alert Threshold	Major Alert Threshold	Alert Threshold
Enterococci	cfu/100mL	40	200	200
Microcystis aeruginosa	cells/mL	5,000	50,000	50,000
Toxic cyanobacteria biovolume	mm^3/L	0.4	4	4
Total cyanobacteria biovolume	mm^3/L	-	10	10
Algal toxins (microcystin variants)	µg/L	NA	10	10

4.5 Benchmarks for downstream rivers

Benchmarks for water quality downstream of WaterNSW's dams and weirs are derived from ANZECC (2018) lowland rivers ecosystem types (Table 4.6).

Table 4.7: Water quality benchmarks downstream of storages

Analyte	Units	Benchmark range
pH	pH units	6.5 - 8.5
Chlorophyll *a*	µg/L	< 5
Dissolved oxygen	% sat	85 – 110
Total nitrogen	mg/L	< 0.5
Total phosphorus	mg/L	< 0.05
Turbidity	NTU	< 50

4.6 Benchmarks for picnic area supplies

Benchmarks for the picnic area supplies are based on ADWG (2011) threshold ranges, where relevant (**Error! Reference source not found.**7). Some benchmarks are prompts for action, such as chlorophyll *a*, which triggers algal monitoring in the picnic area supply.

Table 4.8: Water quality guidelines for specific parameters at picnic areas

Analyte	Units	Threshold
Free chlorine residual	mg/L	> 0.5
pH	pH units	6.5 - 8.5
Turbidity	NTU	< 3
Total iron	mg/L	< 0.3
Total aluminium	mg/L	< 0.2
Total manganese	mg/L	< 0.1
Total coliforms	orgs/100 mL	NA
E. coli	orgs/100 mL	Should not be detected
Algal toxins (microcystin variants)	µg/L	< 1.3
Chlorophyll *a*	µg/L	< 5
Potentially toxin producing algal cells	cells/mL	< 6,500(i)

(i) See cyanobacteria benchmarks in Table 4.8

4.7 Benchmarks for cyanobacteria

WaterNSW routinely monitors levels of algae in major storages to provide early warning of possible bloom conditions and to ensure that raw water supplied to customers can be treated to meet drinking water guidelines. Algal monitoring is also conducted to avoid contaminating downstream waterways through environmental releases or transfers.

While the ADWG stipulate cyanobacteria guidelines and alert levels for drinking water, WaterNSW applies those guidelines to the raw water supplied for treatment in Greater Sydney. At Lake Yarrunga and Fitzroy Falls Reservoir, the only WaterNSW storages in the Sydney catchment area with recreational access, the National Health and Medical Research Council Recreational Waters Guidelines (NHMRC, 2008) for catchments and lakes are applied (**Error! Reference source not found.**8). The raw water and picnic areas benchmarks are from the ADWG.

Table 4.9: Cyanobacteria benchmarks throughout Sydney catchment area

Analyte		Units	Threshold
Catchment and lake sites(i)			
Cells	*Microcystis aeruginosa*	cells/mL	50,000
Toxicity	Microcystin variants	µg/L	10
Biovolume	Total cyanobacteria	mm^3/L	4
Raw water and picnic area water supplies(ii)			
Cells	*Microcystis aeruginosa*	cells/mL	6,500
	Raphidiopsis raciborskii	cells/mL	15,000
	Dolichospermum circinale	cells/mL	20,000
Toxicity	Microcystin variants	µg/L	1.3
	Cylindrospermopsin	µg/L	1.0
	Saxitoxin	µg/L	3.0
Biovolume	Potentially microcystin-producing species	mm^3/L	0.6
	Potentially cylindrospermopsin-producing species	mm^3/L	0.6
	Potentially saxitoxin-producing species	mm^3/L	5

(i) National Health and Medical Research Council Guidelines for Managing Risks in Recreational Water 2008.

(ii) These triggers are based on cell counts, toxin concentration and biovolume ADWG 2011 specify actions in response to various alert level ranges for *Microcystis aeruginosa, Dolichospermum circinale* and *Raphidiopsis raciborskii*, and the consolidated biovolumes of the species known to produce microcystin, saxitoxins and cylindrospermopsin toxins.

4.8 Benchmarks for *Cryptosporidium* and *Giardia*

The ADWG do not contain guideline values for *Cryptosporidium* and *Giardia* in raw or treated drinking water. However, ADWG (2011) recommends a multi-barrier approach to minimise the risks of these pathogens. Investigative testing is encouraged in response to events that could increase the risk of contamination. WaterNSW implements additional monitoring during high-risk events. *Cryptosporidium* and *Giardia* monitoring in the catchments is undertaken to provide early warning to enable optimal configuration of the raw water supply system in the event of high concentrations of protozoan pathogens within the storages. Catchment monitoring also

contributes to the understanding of sources which can then improve the robustness of risk assessments and catchment actions.

5 Routine monitoring

Water quality monitoring was conducted as per the Water Monitoring Program. Samples were collected from catchment streams, lakes and delivery sites and analysed by National Association of Testing Authorities (NATA) accredited laboratories. Online instruments were used to supplement this monitoring. This report summarises the results of routine monitoring compared against appropriate guidelines or benchmarks.

Data from routine samples was extracted from the WaterNSW water quality database. Storage data was filtered so that surface samples were used. Routine data was compared to the relevant guideline, standards and benchmark value for each analyte. The number of guideline exceedances was calculated as a percentage of the total compliance samples taken in the reporting year. The appendices provide summary statistics for all samples collected on each routine sampling occasion.

Compliance was 100% with the ADWG and 99.05% with Raw Water Supply Agreements. Overall, the water quality monitoring of the reservoirs in the declared catchment areas indicated good water quality, apart from occasional impacts primarily associated with algal blooms and the June 2024 inflow event. The impacts of the inflow events in 2023-2024 were managed by adjusting the supply system configuration (e.g., offtake depth changes and source selection) and working with customers to reduce challenges in treating the water.

5.1 Quality Assurance and Quality Control

The WaterNSW quality assurance and quality control (QA/QC) program ensures the sampling and analysis process is accurate and representative. Specific QA/QC samples are collected and analysed to provide confidence that errors are controlled in the sampling and analysis process. Field collected QA/QC samples include field duplicates and field blanks. Trip blanks are also prepared at the laboratory and taken on designated sampling trips. In 2023-24, 3% of the number of routine samples were taken for QA/QC purposes to ensure the validity and accuracy of the WaterNSW's water quality data. This was above the effort on QA/QC recommended by ISO 5667 at 2% of routine samples.

In addition to WaterNSW QA/QC samples, WaterNSW's analytical service providers have management systems that require them to maintain their own internal QA/QC program. These systems are accredited with the NATA and aligns with ISO17025. The analytical service providers conduct internal quality control analysis per each batch of samples including matrix spikes, internal and inter-laboratory duplicates, blanks, replicate analysis and inter-laboratory proficiency trials. The service provider QA/QC specialists analyse conformance with specified

standards of accuracy and precision defined by WaterNSW to identify any contamination, outliers or errors (either random or systemic).

Trip blanks

A total of 59 trip blanks were taken in 2023-24 across the greater Sydney catchment area. Positive detections were recorded in 41 of these samples for Dissolved Organic Carbon (DOC) and Total Organic Carbon. An investigation determined the likely source of organic carbon contamination to be the blank water being supplied to WaterNSW. A change in source of blank water in August 2024 has resulted in a substantial reduction in DOC and TOC positives in blanks. Trace detections were also recorded for nitrogen analytes (7) and filtered iron (1) across 6 individual samples.

Field blanks

Field blanks accounted for 84 samples in 2023-24. The abovementioned organic carbon contamination in the supplied blank water also impacted the performance of the field blanks, with 35 samples recording positives for DOC and/or TOC. Low detections were recorded for trihalomethanes (1), total iron (1), nitrogen (7), phosphorous (1), sodium (2), silicon (1) and phaeophytin (1). Significant numbers of indicator bacteria were recorded in one field blank sample. This was referred to the analytical laboratory and water monitoring teams, with mislabelling of a sample determined to be the likely cause.

Duplicates

WaterNSW has applied the Relative Percent Deviation (RPD) to routine and duplicate samples. Where the RPD is greater than 50% the two sample results are considered anomalous and discussed below. Sample results with detections of less than 10x the Limit of Reporting (LOR) are excluded due to the innate variability of results at low concentrations. Biological results such as bacteria or algae are included although it is noted that there is typically a high degree of variability between routine and duplicate samples.

During 2023-24, 147 duplicate samples were collected across the greater Sydney catchment. A total of 21 analyses identified anomalies when applying the above criteria. These included algal parameters (11), nitrogen (5), total coliforms (2), phosphorous (1), suspended solids (1) and filtered iron (1). When reviewing the nature and analytical methods of these results only the filtered iron and suspended solids were considered significant and required further investigation.

5.2 Warragamba system

Sampling sites in the Warragamba system (including Prospect Reservoir) are shown in Figure 5.1 below.

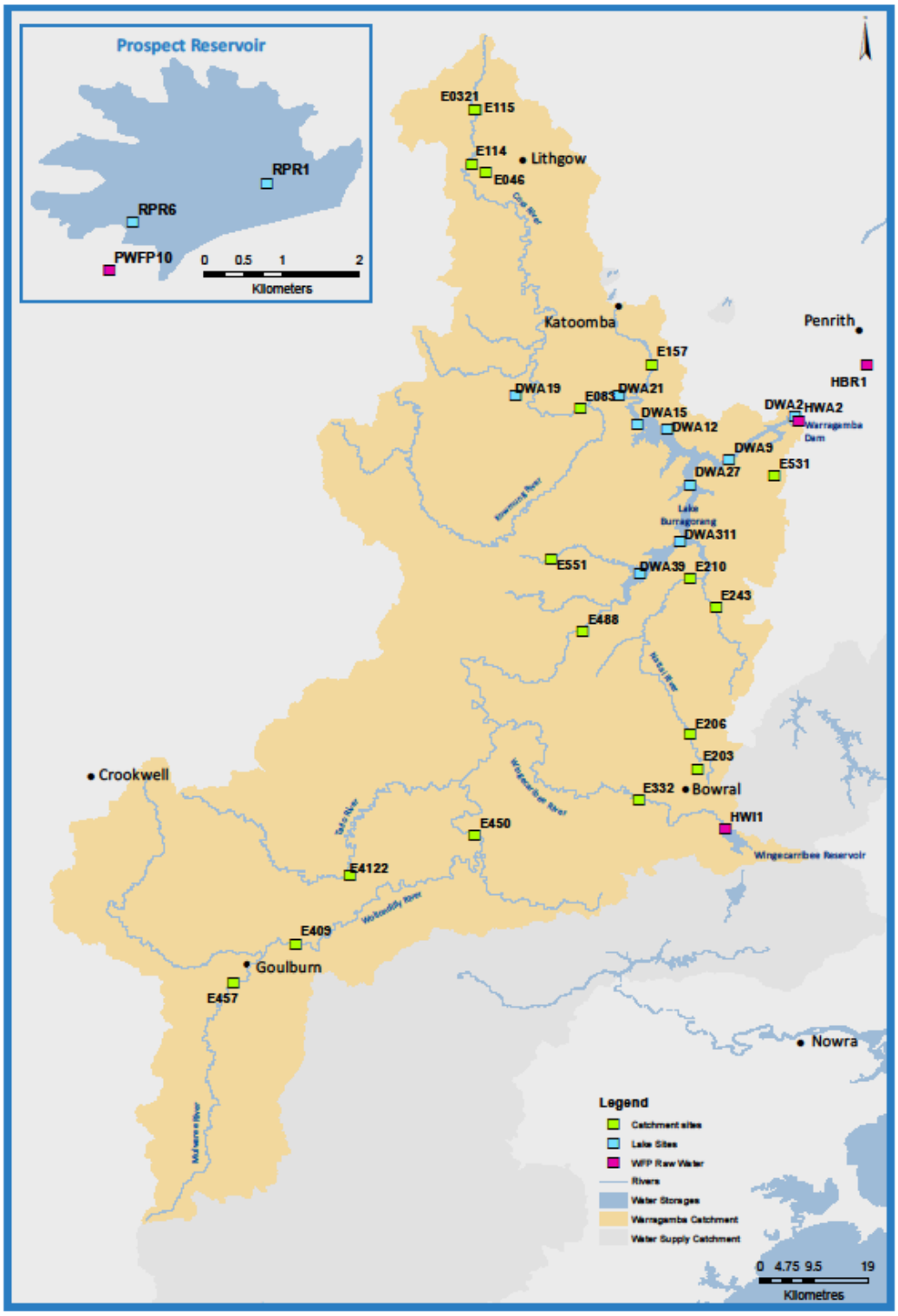

Figure 5.1: Sampling sites in the Warragamba system (Prospect Reservoir inset)

Table 5.1: Warragamba system catchments - percentage of routine samples outside benchmarks

Site	Station Code	Physico-Chemical							Nutrients					Metals			Cyanobacteria	
		Total Alkalinity as CaCO3 (mg/L)	Conductivity @25 C - Field (mS/cm)	Dissolved Oxygen - Field (%Sat)	pH - Field	Total Hardness as CaCO3 (mg/L)	True Colour at 400nm (PES filter)	Turbidity - Field (NTU)	Nitrogen Ammoniacal (mg/L)	Nitrogen Oxidised (mg/L)	Nitrogen Total (mg/L)	Phosphorus Soluble Reactive (mg/L)	Phosphorus Total (mg/L)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Areal Standard Unit (algae)	Chlorophyll-a (ug/L)
Catchments (ANZECC guidelines refer Table 4.4, where there is no applicable benchmark the cells are greyed out).																		
D/S Lake Lyell	E0114		0%	75%	0%			17%	42%	100%	100%	0%	8%	42%		0%		8%
U/S Lake Lyell	E0115		92%	25%	58%			8%	17%	42%	58%	0%	17%	58%		0%		8%
Coxs R. at Lithgow (next to the Power Station)	E0321		100%	58%	25%			17%	75%	100%	75%	8%	75%	92%		0%		17%
Farmers Ck Mt Walker	E046		0%	25%	25%			17%	50%	92%	92%	25%	75%	83%		0%		42%
Coxs at Glenroy Br	E073		0%	56%	11%			11%	33%	89%	100%	11%	44%	44%		0%		33%
Coxs River @ Kelpie Point	E083		0%	25%	25%			8%	17%	58%	33%	0%	25%	42%		0%		25%
Kowmung River @ Cedar Ford	E130		0%	17%	0%			0%	25%	67%	17%	0%	8%	42%		0%		0%
Kedumba River@ Maxwells Crossing	E157		0%	8%	8%			0%	58%	100%	83%	0%	17%	33%		0%		0%
Gibbergunyah Ck 400m d/s of Mittagong STP Disch.	E203		25%	17%	0%			0%	92%	100%	100%	8%	75%	100%		0%		8%
Nattai River @ The Crags	E206		8%	25%	0%			0%	75%	100%	100%	0%	25%	42%		0%		8%
Nattai Ck @ Smallwoods Crossing	E210		42%	17%	0%			0%	67%	75%	50%	0%	8%	75%		0%		0%
Little River @ Fireroad W4I	E243		0%	0%	10%			0%	10%	60%	0%	0%	0%	10%		0%		0%
Mittagong Creek downstream WPCP Bowral	E306		42%	100%	0%			8%	83%	92%	100%	0%	100%	100%		0%		27%
Whites Ck 350m d/s of Moss Vale STP discharge	E3151		83%	100%	17%			0%	92%	100%	100%	75%	100%	92%		0%		33%
Wingecarribee River @ Berrima	E332		0%	83%	0%			8%	83%	92%	100%	17%	100%	100%		0%		67%
Wollondilly River @ Murrays Flat	E409		100%	58%	17%			8%	92%	83%	100%	42%	92%	100%		0%		92%
Wollondilly at Upper Tarlo	E4122		67%	83%	17%			0%	67%	58%	83%	0%	67%	58%		0%		50%
Wollondilly River at ford 1km u/s Paddys River	E433		0%	75%	8%			0%	100%	67%	58%	0%	33%	100%		0%		33%
Wollondilly River @ Golden Valley	E450		58%	17%	8%			17%	83%	92%	100%	17%	58%	67%		0%		75%
Mulwaree River @ Towers Weir	E457		100%	75%	8%			8%	92%	83%	100%	83%	92%	83%		0%		83%
Wollondilly River @ Jooriland	E488		58%	8%	33%			0%	42%	50%	83%	0%	25%	58%		0%		25%
Wollondilly River @ u/s Goul Rossi Weir	E490		92%	67%	17%			8%	67%	17%	100%	8%	75%	50%		0%		50%
Werriberri Ck @ Werombi	E531		0%	58%	33%			0%	92%	67%	50%	0%	8%	75%		0%		0%
Tonalli R. @ Fire Road W2 (Site No.2)	E551		67%	42%	8%			0%	25%	67%	0%	0%	8%	8%		0%		0%

Site	Station Code	Physico-Chemical							Nutrients					Metals			Cyanobacteria	
		Total Alkalinity as CaCO3 (mg/L)	Conductivity @25 C - Field (mS/cm)	Dissolved Oxygen - Field (%Sat)	pH - Field	Total Hardness as CaCO3 (mg/L)	True Colour at 400nm (PES filter)	Turbidity - Field (NTU)	Nitrogen Ammoniacal (mg/L)	Nitrogen Oxidised (mg/L)	Nitrogen Total (mg/L)	Phosphorus Soluble Reactive (mg/L)	Phosphorus Total (mg/L)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Areal Standard Unit (algae)	Chlorophyll-a (ug/L)
Storages (ANZECC guidelines refer Table 4.3, where there is no applicable benchmark the cells are greyed out).																		
Lake Burragorang Coxs R. arm 24km U/S of dam wall	DWA12			36%	20%			0%	24%	96%	80%	4%	32%	48%		0%		16%
Lake Burragorang Coxs R. arm 4km U/S Butchers Ck	DWA15			33%	33%			0%	50%	83%	83%	0%	50%	50%		0%		50%
Lake Burragorang Kedumba R. 36km U/S of dam wall	DWA19			33%	17%			0%	50%	67%	33%	0%	50%	0%		0%		83%
Lake Burragorang 500m U/S of dam wall	DWA2			38%	27%			0%	42%	88%	92%	4%	31%	42%		0%		27%
Lake Burragorang Coxs R. arm 37km U/S of dam wall	DWA21			33%	17%			0%	33%	83%	33%	0%	50%	0%		0%		83%
Lake Burragorang Wollondilly R. arm 23km U/S of dam wall	DWA27			44%	28%			0%	12%	96%	84%	4%	28%	56%		0%		12%
Lake Burragorang Wollondilly R. arm 300m U/S of Nattai R.	DWA311			33%	33%			0%	33%	83%	100%	0%	17%	50%		0%		33%
Lake Burragorang Wollondilly R. arm 40km U/S dam wall	DWA39			50%	33%			0%	50%	83%	100%	0%	33%	83%		0%		100%
Lake Burragorang 14km U/S of dam wall	DWA9			44%	8%			0%	44%	96%	92%	0%	24%	52%		0%		20%
Prospect Reservoir @ Midlake	RPR1			17%	8%			0%	50%	83%	8%	0%	0%	58%		0%		33%
Prospect Reservoir @ Inlet to RWPS	RPR6			0%	0%			0%	83%	100%	17%	0%	0%	83%		0%		33%
Raw Water (raw water supply agreement site specific standards refer Table 4.2, where there is no applicable benchmark the cells are greyed out).																		
Orchard Hills WFP raw water	HBR1	0%				0%	0%	0%						0%	0%	0%	0%	
Warragamba WFP raw water	HWA2	0%				0%	0%	0%						0%	0%	0%	0%	
Prospect WFP Inlet - Channel 2, 2nd dosing bridge	PWFP10	0%				0%	0%	0%						0%	0%	0%	0%	

5.2.1 Catchments

Water quality in Lake Burragorang's river catchments in 2023-24 was influenced by the broader climatic conditions. The first half of the reporting year had only moderate inflows leading to reduced export of water quality from the catchment to the lake. In April and June of 2024, large inflow events were observed which resulted in large variability in riverine water quality. Catchments dominated by agricultural and urban land uses regularly exceeded ANZECC benchmarks during and subsequent to the larger inflow events.

Water monitoring sites in the upstream parts of all the catchments continued to frequently exceed benchmarks, particularly for nitrogen, aluminium and conductivity irrespective of hydrology. Nitrogen and aluminium continued to be elevated throughout the catchment streams in both of the major arms of the lake. Of note, while total phosphorus exceeded consistently across most sites, soluble reactive phosphorus exceedances were infrequent suggesting recurring wet conditions has led to the transport of organic bound or mineralised phosphorus.

Highly protected natural catchments such as the Kowmung, Tonalli and Little Rivers performed better for most parameters when compared to drainage units from more developed catchments. These sites did show some level of exceedances for nitrogen and aluminium. Additionally, sites in the Wollondilly catchment directly downstream of Goulburn showed higher levels of exceedances for chlorophyll-a and dissolved Oxygen.

The Coxs River upstream of Lake Lyell continues to show significant water quality influences from urbanisation in and around Lithgow township. Notable improvements in water quality performance in the Coxs River is apparent once the river enters protected areas downstream of Lake Lyell.

5.2.2 Storages

Lake Burragorang showed a higher level of exceedances for nitrogen and aluminium at all sites. The guideline for nitrogen is above the longer-term average for the lake and higher results are expected. Aluminium is also an analyte that is expected to be consistently above the guideline due to the majority of the catchment being sandstone and rich in aluminosilicates.

Chlorophyll-*a* exceedances were directly related to the proximity to inflow locations where the closer to the Dam Wall the site is, the lower the frequency of exceedance. No significant algal growth to the level of a phytoplankton bloom was observed in 2023-24.

Water quality in Prospect Reservoir is usually defined by water quality in Lake Burragorang as inter basin transfers represent the majority of inflow. Similarly to Lake Burragorang, a significant number of exceedances for nitrogen and aluminium were observed. Water quality was of

generally good quality and posed few challenges for treatment to the Prospect Water Filtration Plant.

5.2.3 Water Filtration Plants

Water supplied for filtration remained of high quality throughout the period with no exceedances recorded at Prospect, Orchard Hills or Warragamba WFPs. All results met targets as defined within the Raw Water Supply Agreement.

5.3 Upper Nepean system

Sampling sites in the Upper Nepean system are shown in Figure 5.2 below.

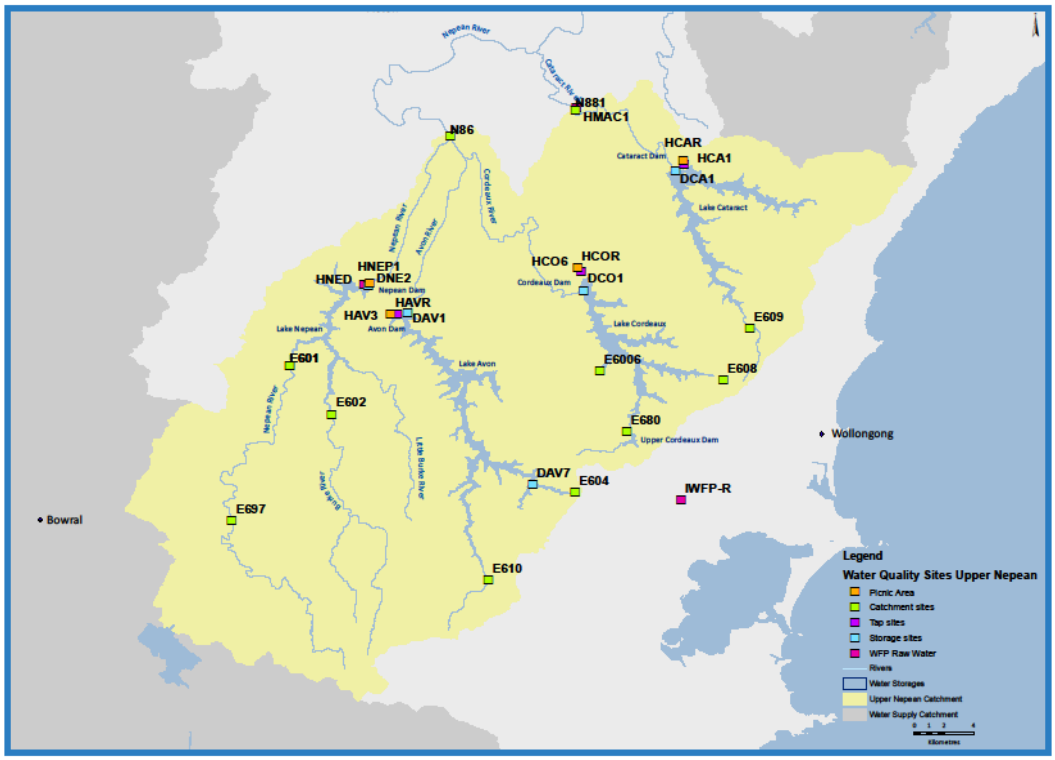

Figure 5.2: Sampling sites in the Upper Nepean system.

Table 5.2: Upper Nepean catchments - percentage of routine samples outside benchmarks

Site	Station Code	Physico-Chemical							Nutrients					Metals			Cyanobacteria	
		Total Alkalinity as CaCO3 (mg/L)	Conductivity @25 C - Field (mS/cm)	Dissolved Oxygen - Field (%Sat)	pH - Field	Total Hardness as CaCO3 (mg/L)	True Colour at 400nm (PES filter)	Turbidity - Field (NTU)	Nitrogen Ammoniacal (mg/L)	Nitrogen Oxidised (mg/L)	Nitrogen Total (mg/L)	Phosphorus Soluble Reactive (mg/L)	Phosphorus Total (mg/L)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Areal Standard Unit (algae)	Chlorophyll-a (ug/L)
Catchments (ANZECC guidelines refer Table 4.4, where there is no applicable benchmark the cells are greyed out).																		
Sandy Ck inflow	E6006		0%	75%	100%			0%	67%	17%	0%	0%	25%	75%		0%		0%
Nepean River @ Inflow to Lake Nepean	E601		0%	0%	0%			0%	33%	100%	58%	0%	17%	42%		0%		0%
Burke River @ inflow to Lake Nepean	E602		0%	0%	42%			0%	50%	8%	0%	0%	0%	50%		0%		0%
Little Burke R. @ Nepean Dam Inflow	E603		0%	33%	100%			0%	67%	0%	0%	0%	0%	58%		0%		0%
Flying Fox Ck. No 3	E604		0%	55%	0%			0%	18%	100%	36%	0%	0%	9%		0%		0%
Goondarrin Creek @ Kemira 'D' cast	E608		0%	33%	17%			0%	50%	100%	8%	0%	8%	83%		0%		0%
Cataract River downstream Angels Creek	E609		0%	100%	83%			0%	100%	100%	17%	0%	8%	83%		0%		0%
Avon River - Summit Tank	E610		0%	42%	17%			0%	17%	0%	0%	0%	8%	42%		0%		0%
Loddon R. Inflow	E676		0%	33%	100%			0%	75%	25%	0%	0%	0%	100%		0%		0%
Cordeaux River at causeway between U.cord. 1 & 2	E680		0%	42%	25%			0%	83%	67%	8%	0%	8%	33%		0%		17%
Nepean River @ AT McGuire's Crossing	E697		0%	50%	0%			0%	42%	92%	83%	0%	33%	92%		0%		17%
Storages (ANZECC guidelines refer Table 4.3, where there is no applicable benchmark the cells are greyed out).																		
Lake Avon @ 45m U/S dam wall	DAV1			25%	100%			0%	67%	83%	0%	0%	0%	17%		0%		0%
Lake Avon @ 3 km D/S Gallahers Ck Jn	DAV16			25%	83%			0%	50%	50%	0%	0%	8%	0%		0%		0%
Lake Avon @ Upper Avon Valve Chamber	DAV7			25%	42%			0%	50%	42%	0%	0%	0%	0%		0%		8%
Lake Cataract @ Dam wall	DCA1			25%	83%			0%	42%	33%	0%	0%	17%	100%		0%		17%
Lake Cataract @ Cataract arm 5km U/S	DCA2			18%	100%			0%	73%	36%	0%	0%	0%	100%		0%		9%
Lake Cataract @ Loddon arm 4.5km U/S	DCA3			20%	100%			0%	40%	40%	0%	0%	0%	100%		0%		20%
Lake Cordeaux 60 m U/S of dam wall	DCO1			33%	33%			0%	67%	50%	0%	0%	17%	75%		0%		67%
Lake Cordeaux @ Jn. of Kentish & Cord. R.	DCO3			25%	25%			0%	58%	58%	0%	0%	25%	83%		0%		67%
Lake Nepean 50 m U/S of dam wall	DNE2			42%	50%			0%	75%	100%	67%	8%	50%	83%		0%		17%
Lake Nepean @ D/S Burke Junction	DNE6			50%	58%			0%	75%	100%	67%	0%	33%	83%		0%		17%
Raw Water (raw water supply agreement site specific standards refer Table 4.2, where there is no applicable benchmark the cells are greyed out).																		
Macarthur WFP raw water at Inlet to PS	HMAC1	0%				8%	0%	0%						0%	8%	0%	0%	

Site	Station Code	Physico-Chemical							Nutrients					Metals			Cyanobacteria	
		Total Alkalinity as CaCO3 (mg/L)	Conductivity @25 C - Field (mS/cm)	Dissolved Oxygen - Field (%Sat)	pH - Field	Total Hardness as CaCO3 (mg/L)	True Colour at 400nm (PES filter)	Turbidity - Field (NTU)	Nitrogen Ammoniacal (mg/L)	Nitrogen Oxidised (mg/L)	Nitrogen Total (mg/L)	Phosphorus Soluble Reactive (mg/L)	Phosphorus Total (mg/L)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Areal Standard Unit (algae)	Chlorophyll-a (ug/L)
Nepean WFP raw water	HNED	0%				0%	0%	0%						0%	0%	0%	0%	
Illawarra WFP raw water	IWFP-R	0%				0%	0%	0%						0%	0%	0%	0%	

5.3.1 Catchments

Water quality across the Upper Nepean catchment sites displays variations stemming from rainfall, land use and natural catchment characteristics. The Upper Nepean catchment experienced significant catchment wide rainfall events in April, May and June 2024, as well as more localised rainfall events at other times throughout the year. Turbidity in these catchment streams increased in response to the higher flows, then quickly declined as flows subsided. Routine monitoring did not capture any instances of elevated turbidity above the guideline value due to the timing of sample collection.

The number of benchmark exceedances for total aluminium improved at seven of the Upper Nepean Catchment sites when compared to the previous year. However, it remains the parameter with the overall highest number of benchmark exceedances for the Upper Nepean catchment sites. This is primarily due to the natural geology of the catchments, coupled with the periods of high rainfall experienced in the 2023-2024 year. Peak aluminium concentrations were recorded at many sites following the significant rainfall events in April, May or June 2024. pH is also influenced by the natural geology of some Upper Nepean sub-catchments, with Sandy Creek, Little Burke River, Cataract River and Loddon River all continuing longer term trends of consistently registering pH results below the 6.5 pH unit lower guideline value. Dissolved oxygen saturation levels also fell below the lower guideline of 90% on multiple occasions at most sites, particularly during periods of lower flow.

Frequent benchmark exceedances were also recorded for nutrients across the Upper Nepean catchment streams, with ammoniacal nitrogen and oxidised nitrogen again recording the highest number of exceedances. Total nitrogen and total phosphorus also recorded multiple exceedances, particularly in the two Nepean River sites due to the rural residential land use in this sub-catchment. There were again no guideline exceedances recorded for soluble reactive phosphorus. The lower levels of available phosphorus in most streams limited algal growth, resulting in only a small number of chlorophyll-a guideline exceedances.

5.3.2 Storages

Water quality in the Upper Nepean storages in 2023-24 was again impacted by rainfall, particularly the events in April, May and June 2024. These rain events generated significant wet weather inflows, transporting increased sediment, organics, and catchment-derived metals into the storages and adversely impacting water quality.

Turbidity within the storages increased following rain events, however full compliance to the ANZECC benchmark was still achieved, with all routine samples remaining below the 20 NTU guideline value.

Elevated concentrations of total aluminium in Lake Cataract, Lake Cordeaux and Lake Nepean continued the trend from previous years with a high number of benchmark exceedances recorded in these three storages. Peak concentrations were recorded following the significant rain events mentioned above. Total aluminium in Lake Avon however experienced a marked improvement from the previous reporting period, with no benchmark exceedances recorded for the 2023-2024 reporting period at Upper Avon, the point of supply for Illawarra WFP. Manganese concentrations remained consistently low and achieved full compliance against the ANZECC benchmark.

In a pattern similar to the previous year, compliance with nutrient levels varied across the storages. Lake Nepean again registered the highest number of exceedances out of the Upper Nepean storages for all forms of nitrogen and phosphorus. The primary source of these elevated nutrients is runoff from the rural residential land use areas within the Nepean River sub-catchment. Bioavailable forms of nitrogen (ammoniacal and oxidised nitrogen) recorded exceedances in all storages. While total nitrogen and soluble reactive phosphorus achieved full compliance except in Lake Nepean.

Despite a minor decline this reporting period, Lake Cordeaux continued the trend of recording the highest percentage of chlorophyll-a exceedances of the Upper Nepean storages. Chlorophyll-a concentrations in the other storages remained relatively low, with benchmark exceedances recorded at 20% or lower in Lake Avon, Lake Cataract and Lake Nepean. Lake Avon in particular recorded a notable improvement in chlorophyll-a compliance from the previous year, with only one exceedance recorded in total at the three Lake Avon sites.

5.3.3 Water Filtration Plants

Full compliance with the raw water standards was achieved for Illawarra WFP and Nepean WFP. Macarthur WFP had two exceedances to the raw water standards which are detailed below. All three plants had 100% compliance with health related characteristics.

The first exceedance at Macarthur WFP was for total iron in March 2024. At this time, supply to Macarthur WFP was being sourced 100% from Cataract dam, due to maintenance work closing the Nepean Tunnel and preventing the blending of supply from the other Upper Nepean storages. Lake Cataract contained high concentrations of iron at the time, due to the release of iron from sediments into the water column in the reducing environment of the low dissolved oxygen hypolimnion, that occurs each year due to lake stratification.

The other exceedance at Macarthur WFP was for total hardness in June 2024. This was due to the dilution of calcium and magnesium concentrations in all Upper Nepean storages, following the multiple significant rain events in the preceding months.

5.4 Woronora system

Sampling sites in the Woronora system are shown in Figure 5.3 below.

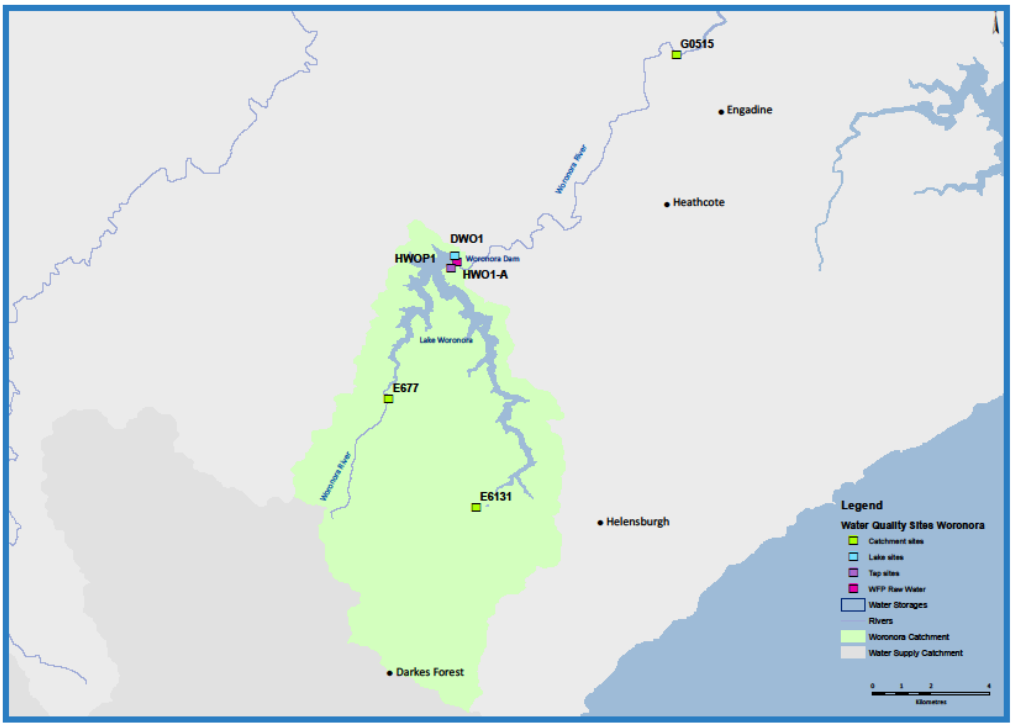

Figure 5.3: Sampling sites in the Woronora system.

Table 5.3: Woronora system catchments - percentage of routine samples outside benchmarks

Site	Station Code	Physico-Chemical							Nutrients					Metals			Cyanobacteria	
		Total Alkalinity as CaCO3 (mg/L)	Conductivity @25 C - Field (mS/cm)	Dissolved Oxygen - Field (%Sat)	pH - Field	Total Hardness as CaCO3 (mg/L)	True Colour at 400nm (PES filter)	Turbidity - Field (NTU)	Nitrogen Ammoniacal (mg/L)	Nitrogen Oxidised (mg/L)	Nitrogen Total (mg/L)	Phosphorus Soluble Reactive (mg/L)	Phosphorus Total (mg/L)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Areal Standard Unit (algae)	Chlorophyll-a (ug/L)
Catchments (ANZECC guidelines refer Table 4.4, where there is no applicable benchmark the cells are greyed out).																		
Waratah Rivulet d/s Flatrock Crossing	E6131		0%	67%	0%			0%	42%	33%	8%	0%	0%	25%		0%		0%
Woronora R. Inflow	E677		0%	58%	100%			0%	42%	0%	0%	0%	0%	83%		0%		8%
Storages (ANZECC guidelines refer Table 4.3, where there is no applicable benchmark the cells are greyed out).																		
Lake Woronora @ Honeysuckle Ck Junction	DWO_THMD			33%	83%			0%	92%	100%	0%	0%	0%	100%		0%		0%
Lake Woronora 50 m U/S of dam wall	DWO1			33%	92%			0%	92%	100%	0%	0%	0%	100%		0%		0%
Raw Water (raw water supply agreement site specific standards refer Table 4.2, where there is no applicable benchmark the cells are greyed out).																		
Woronora WFP raw water	HWO1-A	0%				0%	0%	0%						8%	0%	0%	0%	

5.4.1 Catchments

Waratah Rivulet and Woronora River recorded significant increases in flow in response to rainfall events in April, May and June 2024. Smaller events were also recorded at other times throughout the year. Turbidity in these catchment streams increased in response to the higher flows, then quickly declined as flows subsided. Routine monitoring did not capture any instances of elevated turbidity above the guideline value due to the timing of sample collection.

Total aluminium was also influenced by high flows, combined with the natural catchment characteristics, with peak concentrations of aluminium recorded following heavy rain events due to the transportation of sandstone particles from the catchment. Both catchment stream sites recorded a reduction in the number of total aluminium benchmark exceedances when compared to the previous year. With a comparison between the two sites showing that Woronora River again recorded more total aluminium exceedances than Waratah Rivulet. Woronora River also recorded a high number of pH results falling below the lower guideline value of 6.5 pH units.

Nutrient compliance in Woronora River was unchanged from the previous year, with full compliance to all forms of nitrogen and phosphorus, except for ammoniacal nitrogen. Waratah Rivulet recorded an increasing number of ANZECC benchmark exceedances for nutrients when compared to last year, with ammoniacal nitrogen, oxidised nitrogen and total nitrogen all exceeding benchmarks at times. Phosphorus recorded full compliance to the benchmarks. Chlorophyll-a remained below benchmark guidelines in Waratah Rivulet despite the increased number of nitrogen exceedances.

Dissolved oxygen saturation levels fell below the lower guideline of 90% at both sites on multiple occasions. The majority of these instances occurred during the warmer months of the year where warmer air temperatures coincided with a period of lower flow conditions and increased biological activity.

5.4.2 Storage

Water quality in Lake Woronora in 2023-2024 was again impacted by multiple rainfall events that generated significant inflows into the storage. Turbidity increased in the storage following the rainfall events of April, May and June 2024, however full compliance to the ANZECC benchmark was still achieved, with all routine samples remaining below the 20 NTU guideline value.

Total aluminium began this reporting period with elevated concentrations due to rainfall events in the previous reporting period. Concentrations were gradually declining throughout the year,

until the significant rain events at the end of the reporting period saw elevated concentrations return.

Benchmark comparisons for nutrients saw full compliance for total phosphorus, soluble reactive phosphorus and total nitrogen. While oxidised nitrogen and ammoniacal nitrogen continued the trend from previous years with a high number of benchmark exceedances recorded in Lake Woronora. Algal activity in the lake remained low with no benchmark exceedances recorded above the 5 µg/L limit at either lake site, which was a minor improvement on the previous year.

Dissolved oxygen fell below the lower guideline of 90% saturation during the cooler months of the year from April to July. pH again saw a high number of exceedances at both sites due to the low pH of Lake Woronora.

5.4.3 Water Filtration Plant

Near full compliance with the raw water standards was achieved for supply to Woronora WFP, with a single exceedance of total aluminium the only exception. This exceedance occurred in June 2024 following successive rain events transporting aluminium from the catchment into the storage. All samples complied with ADWG for health-related characteristics.

5.5 Blue Mountains system

Sampling sites in the Blue Mountains system are shown in Figure 5.4 below.

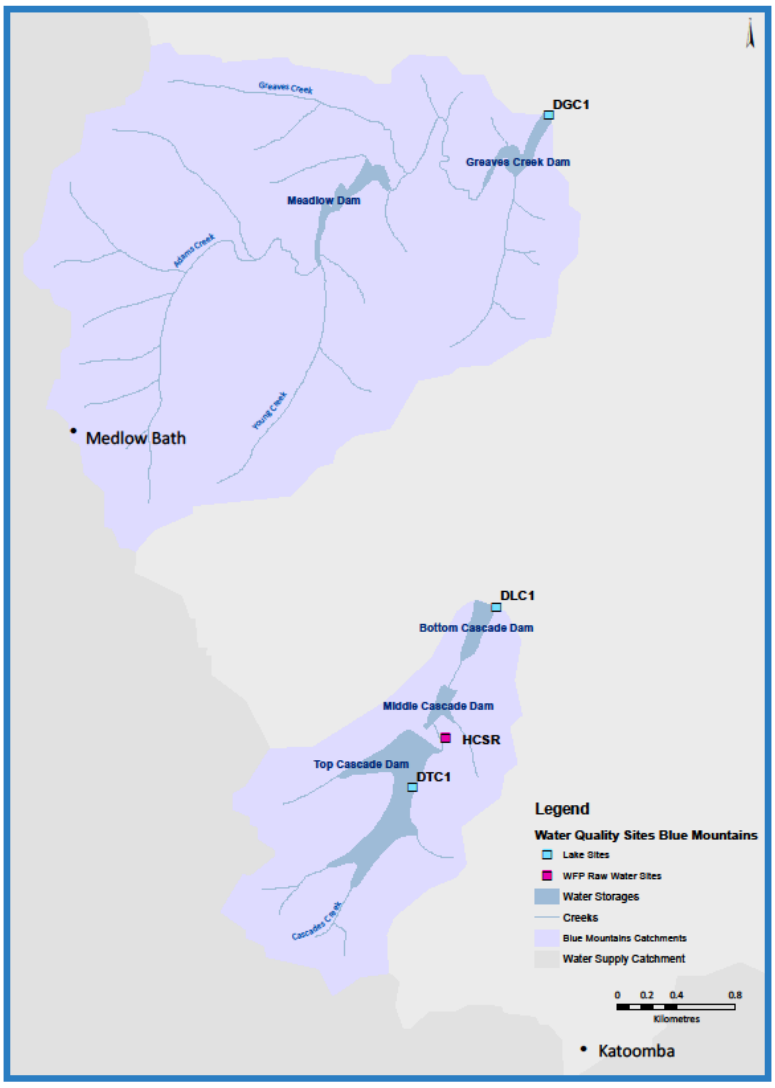

Figure 5.4: Sampling sites in the Blue Mountains system.

Table 5.4: Blue Mountains system storages - percentage of routine samples outside benchmarks

Site	Station Code	Physico-Chemical							Nutrients					Metals			Cyanobacteria	
		Total Alkalinity as CaCO3 (mg/L)	Conductivity @25 C - Field (mS/cm)	Dissolved Oxygen - Field (%Sat)	pH - Field	Total Hardness as CaCO3 (mg/L)	True Colour at 400nm (PES filter)	Turbidity - Field (NTU)	Nitrogen Ammoniacal (mg/L)	Nitrogen Oxidised (mg/L)	Nitrogen Total (mg/L)	Phosphorus Soluble Reactive (mg/L)	Phosphorus Total (mg/L)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Areal Standard Unit (algae)	Chlorophyll-a (ug/L)
Storages (ANZECC guidelines refer Table 4.3, where there is no applicable benchmark the cells are greyed out).																		
Lake Greaves @ dam wall	DGC1			33%	100%			0%	50%	100%	0%	0%	17%	100%		0%		0%
Lower Cascade Lake 25 m U/S of dam wall	DLC1			33%	33%			0%	50%	83%	0%	0%	0%	0%		0%		17%
Upper Cascade Lake 20m U/S of dam wall	DTC1			33%	33%			0%	58%	75%	0%	0%	8%	25%		0%		50%
Raw Water (raw water supply agreement site specific standards refer Table 4.2, where there is no applicable benchmark the cells are greyed out).																		
Cascade WFP raw water	HCSR	0%				0%	0%	0%						0%	0%	0%	8%	

5.5.1 Catchments

The Blue Mountains catchments are very small (<20 km^2 in total), and inflow quality is represented by water quality in the lakes. There are no routine monitoring sites in the Blue Mountains catchments.

5.5.2 Storages

The Blue Mountains lakes were impacted by a wet weather event in April 2024. The event saw significant inflows into the system despite the relatively small catchment. In Top Cascade and Lower Cascade lakes impacts were isolated to the bottom waters. Greaves Creek Lake was impacted through the water column seeing elevated colour, organics and metals. Other rainfall events did not impact the system.

Dissolved oxygen concentrations were variable through the system due to intermittent operation of the destratification systems in response to rainfall events. All exceedances were only slightly out of target range. pH was outside of benchmarks for 100% of samples at Greaves Creek which has been seen in previous years, ranging from 4.4 to 5.4 units. Exceedances for pH at Lower and Top Cascades lakes were only minor.

Elevated nitrogen, specifically ammoniacal and oxidised nitrogen, was again seen across the lake system, increasing from previous years. This is likely due to recent years seeing high rainfall. Aluminium concentrations remain elevated in Greaves Creek exceeding benchmarks in all samples again this year. Concentrations in Lower and Top Cascades have improved with fewer exceedances recorded.

There has been an increase in chlorophyll-a concentrations at Top Cascade this year with 50% of samples outside of guidelines. This indicates an increase in algal activity which has been observed through the reporting period. A decrease in chlorophyll-a at Greaves Creek saw no exceedances while Lower Cascade was similar to last year.

5.5.3 Water Filtration Plant

Raw water supply to Cascade WFP was good throughout the year with minimal exceedances of the raw water supply agreements. In March 2024 the algal ASU recorded 2,300 ASU/mL due to an increase in diatom numbers. Concentrations reduced in the April sample, although remained elevated through to June 2024.

Last year saw one exceedance for aluminium although in this reporting period aluminium remained relatively low.

5.6 Shoalhaven system

Sampling sites in the Shoalhaven system are shown in Figure 5.5 below.

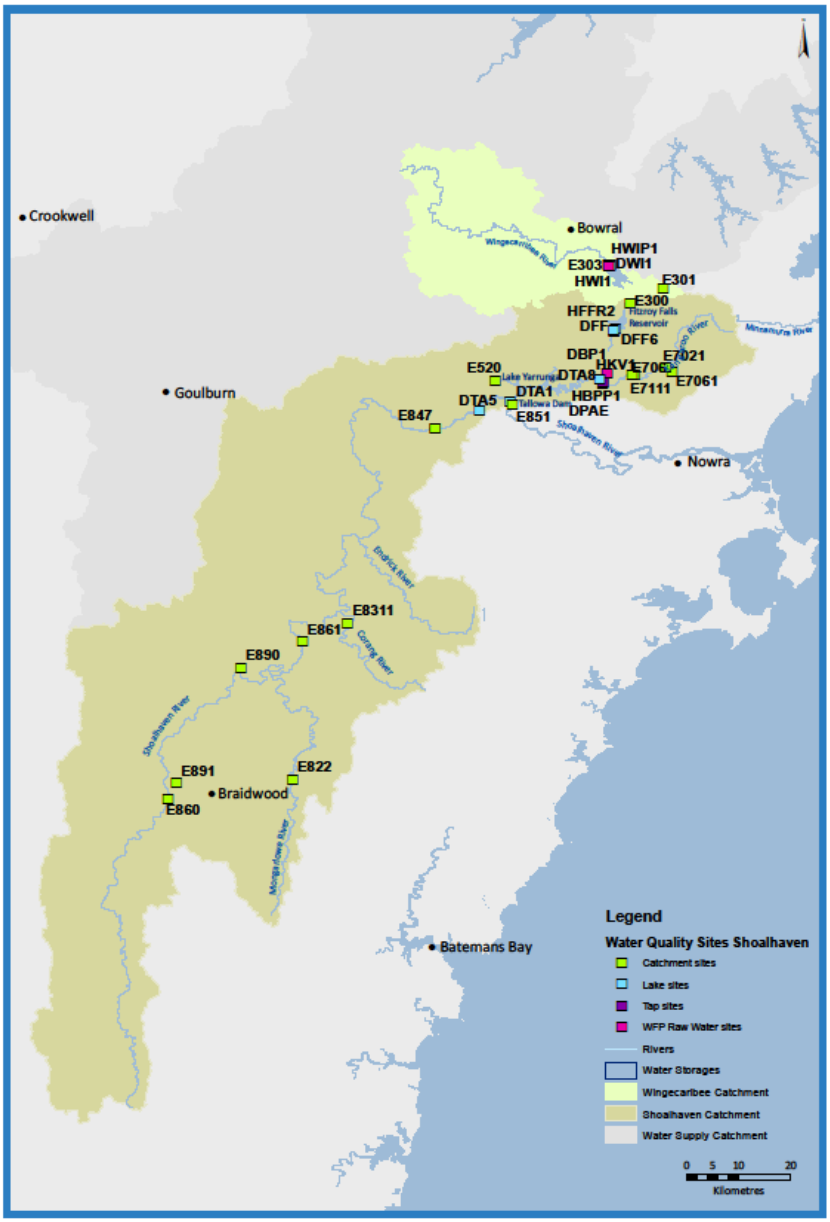

Figure 5.5: Sampling sites in the Shoalhaven system

Table 5.5: Shoalhaven system catchments - percentage of routine samples exceeding benchmarks

Site	Station Code	Physico-Chemical							Nutrients					Metals			Cyanobacteria	
		Total Alkalinity as CaCO3 (mg/L)	Conductivity @25 C - Field (mS/cm)	Dissolved Oxygen - Field (%Sat)	pH - Field	Total Hardness as CaCO3 (mg/L)	True Colour at 400nm (PES filter)	Turbidity - Field (NTU)	Nitrogen Ammoniacal (mg/L)	Nitrogen Oxidised (mg/L)	Nitrogen Total (mg/L)	Phosphorus Soluble Reactive (mg/L)	Phosphorus Total (mg/L)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Areal Standard Unit (algae)	Chlorophyll-a (ug/L)
Catchments (ANZECC guidelines refer Table 4.4, where there is no applicable benchmark the cells are greyed out).																		
Yarrunga Creek @ Wildes Meadow	E300		0%	92%	17%			0%	100%	100%	100%	0%	58%	100%		0%		33%
Caalang CK Old Kangaloon Rd Ford	E301		0%	42%	17%			0%	75%	100%	100%	0%	50%	92%		0%		8%
Bundanoon Creek at the Rocks	E520		8%	42%	0%			0%	83%	83%	92%	0%	50%	75%		0%		67%
Brogers Creek@Clinton Park	E7021		0%	8%	8%			0%	92%	100%	50%	0%	83%	100%		0%		17%
Kangaroo River @ Hampden Bridge	E706		0%	25%	8%			0%	92%	100%	92%	42%	100%	92%		0%		25%
Kangaroo River at Oakdale	E7061		0%	17%	8%			0%	67%	92%	8%	0%	33%	100%		0%		8%
Mongarlowe R. at Mongarlowe	E822		0%	58%	17%			0%	83%	83%	8%	0%	25%	83%		0%		8%
Corang River	E8311		0%	25%	17%			0%	83%	25%	17%	0%	8%	75%		0%		0%
Shoalhaven R @ Fossickers Flat	E847		0%	0%	8%			0%	67%	75%	67%	0%	42%	67%		0%		0%
Shoalhaven R @ Mount View	E860		0%	8%	8%			8%	58%	58%	33%	8%	83%	100%		0%		17%
Shoalhaven R @ Hillview	E861		0%	17%	17%			0%	58%	50%	42%	8%	58%	100%		0%		50%
Boro Ck @ Marlowe	E890		0%	100%	25%			8%	92%	92%	92%	8%	83%	100%		0%		25%
Gillamatong Creek @ Braidwood	E891		92%	100%	0%			0%	100%	100%	100%	75%	100%	75%		0%		50%
Storages (ANZECC guidelines refer Table 4.3, where there is no applicable benchmark the cells are greyed out).																		
Bendeela Pondage	DBP1			33%	0%			17%	100%	100%	100%	17%	100%	100%		0%		67%
Lake Fitzroy Falls @ Midlake	DFF6			25%	8%			0%	100%	83%	92%	0%	92%	83%		0%		92%
Lake Yarrunga@ 100m from Dam Wall	DTA1			50%	0%			0%	92%	83%	67%	8%	92%	83%		0%		75%
Lake Yarrunga @ Shoalhaven River	DTA5			67%	0%			17%	100%	83%	50%	25%	100%	83%		0%		33%
Lake Yarrunga @ Kangaroo R at Bendeela PS	DTA8			42%	8%			0%	92%	100%	75%	42%	100%	100%		0%		83%
Wingecarribee Lake at outlet	DWI1			17%	17%			0%	100%	67%	83%	0%	92%	17%		0%		100%
Raw Water (raw water supply agreement site specific standards refer Table 4.2, where there is no applicable benchmark the cells are greyed out).																		
Kangaroo Valley WFP Inlet	HKV1	8%			0%	0%	0%	8%							0%	0%	8%	
Wingecarribee WFP raw water	HWI1	0%			0%	0%	0%	0%							0%		17%	

5.6.1 Catchments

Catchment streams in the Shoalhaven generally are more hydrologically active and combined with significant levels of animal husbandry in the catchment, elevated nutrient export to stream is to be expected. Performance of nitrogen and total phosphorus showed frequent exceedances at all sites noting that filterable reactive phosphorus remained within benchmarks in the majority of samples. Gillamatong Creek draining out of Braidwood township showed consistent exceedances across most parameters whereas the Corang River (draining from Morton National Park) showed the lowest levels of exceedances.

Aluminium and oxidised nitrogen showed the most frequent exceedances across all sites in the catchment. This reflects the frequency of farming occurring across the catchment and the associated land disturbance.

5.6.2 Storages

As reflected by the catchment results, Lake Yarrunga in the Shoalhaven system continued to return high exceedance rates for chlorophyll-*a* and nutrients. This is typical of the Shoalhaven system and reflects the agricultural land use and active hydrology in the catchment.

Aluminium concentrations continued to be high across the Shoalhaven storages, with all lake sites regularly exceeding the guidelines. The high levels of aluminium are typical of the geology of the region.

Wingecarribee Reservoir and Fitzroy Falls Reservoir once again returned a significant number of exceedances for total phosphorus, nitrogen and its derivatives and chlorophyll-*a*, with potentially toxin producing species present on a number of occasions, particularly in Wingecarribee Reservoir.

5.6.3 Water Filtration Plants

Raw water supplied to Kangaroo Valley Water Filtration Plant (WFP) was 100% compliant with the raw water supply standards with the exception of alkalinity (8%), turbidity (8%) and algal areal standard unit (ASU - 8%). The supply point to Kangaroo Valley WFP is in a channel which connects the upstream and downstream portions of the Shoalhaven Hydro scheme. Water quality at this site is influenced by both Lake Yarrunga, Fitzroy Falls Reservoir and the residence time in Bendeela Pondage. Exceedances are related to specific water quality events (inflows – turbidity and alkalinity, algal bloom – ASU) that occur in each of these three impoundments.

Sampling at the inlet of Wingecarribee WFP had 100% compliance against the benchmarks excluding algal ASU. This was due to a large *Cyanonephron* sp. cyanobacterial bloom that persisted throughout most of the year. *Cyanonephron* sp. does not in itself represent toxin or generate problematic metabolites that pose risks to water treatability.

5.6.4 Recreational Monitoring

Fitzroy Falls did not exceed either the major alert benchmarks for enterococci or the primary contact threshold for potentially toxic cyanobacteria. The minor alert benchmark for potentially toxic cyanobacteria was exceeded 18% of the time due to intermittent observations of *Microcystis* sp. and *Planktothrix* sp. Cyanobacteria in the lake was primarily dominated by benign species.

Lake Yarrunga exceeded the minor alert benchmark for enterococci in 42% of samples, a decrease from 8% over the last reporting period. The major alert for enterococci was exceeded 17% of the time following rain events in May and June of 2024. Algal activity was low through the reporting period with no minor or major benchmarks for cyanobacteria exceeded.

Table 5.6: Recreational monitoring - percentage of samples exceeding benchmarks

Site	Station Code	Primary Contact Minor Alert Benchmark Percentage Exceeedance				Secondary Contact & Primary Contact Major Alert Percentage Exceedance			
		Enterococci (cfu/100ml)	Algal Biovolume - Toxic Cyanobacteria (mm3/L)	Algal Count - Toxic Cyanobacteria (cells/mL)	Algal Biovolume - Cyanobacteria (mm3/L)	Enterococci (cfu/100ml)	Algal Biovolume - Toxic Cyanobacteria (mm3/L)	Algal Count - Toxic Cyanobacteria (cells/mL)	Algal Biovolume - Cyanobacteria (mm3/L)
Recreational monitoring (NHMRC guidelines - refer Table 4.5).									
Lake Fitzroy Falls @ Midlake	DFF6	8%	18%	0%	-	0%	0%	0%	0%
Lake Yarrunga @ Kangaroo R at Bendeela PS	DTA8	42%	0%	0%	-	17%	0%	0%	0%

5.7 Algal monitoring

All routine catchment and lake samples are analysed for algae if chlorophyll *a* exceeds 5 µg/L. Selected lake sites, which are the closest point to supplying water filtration plants have unconditional algae counts and speciation undertaken regardless of chlorophyll *a*. At locations with a history of algal activity, seasonal monitoring is conducted more frequently in the warmer months between October and May to facilitate early detection of emerging algal events. Routine algal monitoring is also undertaken in raw water supplied to water filtration plants. Statistical summaries are provided in Appendix A. Refer to section 4.7 for relevant benchmarks.

5.7.1 Warragamba system

Similar to previous years, parts of the Warragamba catchment exposed to urban runoff showed more exceptions than the catchment areas draining from more natural environments. Monitoring sites located in and around Lithgow, Goulburn and Bowral showed higher levels of chlorophyll-*a* than other sites within the Warragamba catchment. Sites of frequent exceedance were specifically around and downstream of Goulburn including Murrays Flat, Golden Valley, Towers and Rossi Weir. Farmers Creek (Lithgow) and Berrima Weir (Bowral) also show frequent exceedances. Other sites throughout the Warragamba catchment performed comparably to previous years.

Potentially toxic cyanobacterial species were detected infrequently (one detection) at six catchment locations in the Warragamba catchment. Sites that showed more frequent detections include Wingecarribee River at Berrima (five samples), Mulwaree River at Towers (four samples) and Whites Creek downstream of Moss Vale STP (two samples). *Microcystis* sp. was the dominant taxa detected at these sites.

In the major arms of Lake Burragorang, sporadic low numbers of potentially toxin producing cyanobacteria were reported in the counts throughout the lake through spring, summer and autumn, peaking with 5866 cells/mL of potentially toxin producing species being detected in the Wollondilly River Arm (DWA39) in March. *Microcystis* sp. was the dominant taxa detected across the lake.

Downstream in the gorge, small positive detections of potentially toxin producing cyanobacteria occurred throughout the year, with the majority of detections occurring from January to April of 2024. Populations of these organisms are managed via drawing from deep in the water column during their presence.

Chlorophyll *a* concentrations in Prospect Reservoir exceeded the benchmarks at a reduced frequency to last year, with 33% of samples, respectively at both the mid lake site and at the inlet to the Raw Water Pumping Station recording results above the threshold. Low concentrations of potentially toxin producing cyanobacterial species were periodically recorded and remained well within supply agreement thresholds. No algal toxins (combined microcystin) were detected during the reporting period.

Algal ASU did not exceed Raw Water Supply Agreement standards at Prospect, Orchard Hills or Warragamba WFPs.

5.7.2 Upper Nepean system

Chlorophyll a concentrations at catchment sites in the Upper Nepean system remain consistently low, with only two sites recording results above the 5 µg/L threshold for algal speciation in 2023-2024. The two sites recording the exceedances were Cordeaux River and Nepean River at McGuire's Crossing, continuing a similar to trend from the previous year.

Algal activity in the Upper Nepean storages varied between the lakes. In line with historical results, Lake Cordeaux again recorded the greatest number of chlorophyll a results above the 5 µg/L benchmark. Lake Avon was the best performing lake in this regard, with only one sample exceeding the chlorophyll benchmark at any of the three Lake Avon sites throughout the year. This was a notable improvement when compared to the previous reporting period. Elevated chlorophyll a levels were frequently measured alongside increased algal ASU concentrations, with Lake Nepean recording the highest ASU levels of the Upper Nepean storages, followed by Lake Cordeaux.

The worst of the elevated ASU experienced in the storages were prevented from impacting the raw water supplied to Macarthur, Nepean and Illawarra WFP's due to appropriate offtake selections. This resulted in no samples from 2023-2024 exceeding the site specific raw water supply agreement for ASU at the filtration plants.

There were occasional detections of potentially toxin producing cyanobacteria in the raw water supplied to the filtration plants. *Microcystis sp.*, *Phormidium sp.* and *Geitlerinema*

splendidum were identified in low numbers in 4 samples across the reporting period (one at Macarthur, one at Nepean and two at Illawarra). Cell numbers in all cases were below the level of concern for toxin production.

5.7.3 Woronora system

The Woronora system continued to record low levels of algal activity in the catchment, storage and at the inlet to Woronora WFP in the 2023-2024 year.

The two catchment sites (Waratah Rivulet and Woronora River) recorded low chlorophyll a concentrations, with only a single sample exceeding the 5 µg/L trigger for algal speciation analysis. Algal activity in Lake Woronora was very low at both storage monitoring locations, with no results rising above the 5 µg/L guideline level for chlorophyll a. Raw water supplied to Woronora WFP for treatment therefore remained of a high standard with low ASU recorded throughout 2023-2024. Small numbers of the potentially toxin producing cyanobacteria *Microcystis sp.* were identified at the inlet to Woronora WFP in April 2024, however there was no concern for toxin production due to the low cell numbers.

5.7.4 Blue Mountains system

Chlorophyll-a concentrations in Lower Cascade were similar to last year with only one exceedance (0 m sample). Chlorophyll-a concentrations at Greaves Creek did not trigger any algal analysis although special monitoring saw some samples speciated around September to October 2024. Algal activity in Greaves Creek during this period was low (< 200 ASU/mL).

At Top Cascade chlorophyll-a concentrations indicate an increase in algal activity through the reporting period (50% above guidelines). From June to December 2023 algal activity was relatively stable with few results > 500 ASU/mL. From January 2024, algal activity increased with the highest concentrations recorded during March 2024. Concentrations remained elevated through to the end of the reporting period. Filter clogging diatoms have remained dominant in the assemblage this year.

Sampling raw water supplied to Cascade WFP was in line with the results from Top Cascade. Concentrations peaked around March 2024, and remained elevated through to June 2024 with diatoms dominant.

5.7.5 Shoalhaven system

Chlorophyll *a* in the Shoalhaven system is noted by higher levels of exceedance in the storages when compared to the catchment. Most sites in the Shoalhaven catchment infrequently showed high concentrations of chlorophyll *a* excepting Bundanoon Creek (67%), Gillamatong Creek (50%) and Hillview on the Shoalhaven River (50%).

All storages in the Shoalhaven system once again exceeded the chlorophyll *a* benchmark regularly throughout the year. Low numbers of potentially toxin producing cyanobacteria were

present in most samples in Bendeela pondage, peaking in August 2023 with a result of 3,387 cells/mL. (*Radiocystis* sp.). Likewise, Fitzroy Falls returned moderate detections of potentially toxin producing cyanobacteria throughout the year, peaking at DFF6 recording 80,056 cells/mL in November 2023 (also *Radiocystis* sp.).

Once again, potentially toxin producing cyanobacteria blooms (*Microcystis* sp.) persisted in Wingecarribee Reservoir throughout the year, with significant concentrations of combined microcystin present in samples taken between February and May 2024. Of note was the large *Cyanonephron* sp. bloom that had occurred from March 2024 and was still continuing through to June 2024. Peak concentrations during this period exceeded 2 million cells/mL of this species. No impacts to water supplied for treatment were observed during this cyanobacteria bloom.

Raw water supplied to Kangaroo Valley Water Filtration Plant exceed the site-specific standard for algal filter clogging potential (ASU) once in 2023 - 2024. Supply to Wingecarribee WFP complied with the guidelines in 83% of samples with the exceptions related to the abovementioned *Cyanonephron* sp. bloom.

5.8 *Cryptosporidium* and *Giardia* monitoring

Routine monitoring is undertaken in catchments, storages and delivery networks at varying frequencies as agreed between WaterNSW, Sydney Water and NSW Health. Statistical summaries are provided in Appendix A.

5.8.1 Catchments

Routine monitoring for *Cryptosporidium* and *Giardia* is undertaken at seven selected streams in the Warragamba catchment as part of the pathogen monitoring program. The sampling schedule is monthly, except for Werriberri Creek (E531) which is weekly. This section discusses routine monitoring for *Cryptosporidium* and *Giardia*, refer to Section 7.1 for wet weather monitoring.

During the reporting period *Cryptosporidium* oocysts were detected in an average of 8% of samples over all sites (ranging from 0 – 17% at any individual site), two in the minor incident range (1-10/10 L). *Giardia* cysts were detected in an average of 33% of samples over all sites (ranging from 0 – 40% at any individual site), with 14 in the minor incident range. The occurrence of *Cryptosporidium* was lower than in the previous reporting period. However, while *Giardia* occurred less frequently, there was an increase in cyst concentrations compared to the previous year.

5.8.2 Storages

Routine monitoring was conducted weekly at Wingecarribee (DWI1) reservoir, and monthly sampling of water from Prospect Reservoir (RPR1) and Lake Oberon (DOBR01). Sampling was also conducted in storages at a higher frequency during events.

Of the 166 routine samples collected during the reporting period, *Cryptosporidium* and *Giardia* (oo)cysts were detected in 7 (4%) and 18 (11%) samples respectively, with none above the alert range for either *Cryptosporidium* or *Giardia*.

5.8.3 Water Filtration Plants

A joint monitoring program for raw water at the inlet to the water filtration plants is undertaken by Sydney Water and results are provided to WaterNSW and NSW Health. Larger sample volumes (up to ~100 L) are used to improve the detection limit and assist in quantifying catchment risk.

There were no incident level detections (i.e. ≥10 (oo)cysts/10 L) of *Cryptosporidium* or *Giardia* from routine monitoring of water at inlet of filtration plants during the reporting period.

5.9 Picnic area monitoring

WaterNSW undertakes routine monitoring at picnic taps where the water is supplied directly from the storages or where potable water is carted in, both water sources undergo chlorination prior to distribution. Annual monitoring is also done at the picnic areas which receive reticulated town water.

Table 5.7: Picnic areas - percentage of samples exceeding benchmarks

Site	Station Code	pH - Field	Turbidity - Field (NTU)	Aluminium Total (mg/L)	Iron Total (mg/L)	Manganese Total (mg/L)	Free Chlorine residual - Field (mg/L)	Chlorophyll-a (ug/L)	Toxic Cyanobacterial Count (cells/mL)	Coliforms Total (cfu/100mL)	E. coli (orgs/100mL)
Picnic taps (PWS guidelines refer Table 4.6)											
Avon Picnic Area Tap	HAV3	2%	0%	0%	23%	0%	100%	0%	0%	4%	0%
Cataract picnic area tap / fountain	HCA1 / HCA2 / HCA3	69%	12%	17%	29%	6%	92%	0%	0%	2%	0%
Cordeaux Picnic Area Tap	HCO6	10%	27%	8%	88%	29%	94%	0%	0%	2%	0%
Fitzroy Falls Picnic Tap	HFFR2	4%	4%	0%	4%	2%	71%	0%	0%	25%	2%

Exceedances in turbidity have been recorded this year at Cataract and Cordeaux due to the impact of wet weather events in April, May and June. Significant rainfall in April increased the turbidity in source waters and affected turbidity in the picnic area supply for an extended period of time. As the critical limit was exceeded picnic areas were signposted as not suitable for drinking. Fitzroy Falls recorded two turbidity exceedances while no exceedances were recorded at Avon.

Low residual chlorine was again observed in the picnic area end taps. Water usage at the picnic taps can be low and variable, which leads to long residence time in the reticulation system, causing chlorine decay. The efficacy of chlorination is based on chlorine

concentrations and contact times at the dosing plants, as well as the absence of indicator bacteria. There was one sampling occasion that detected *E. coli* (1 cfu/100 mL) at Fitzroy Falls and follow-up sampling did not identify any issues with the supply.

Exceedances in aesthetic guidelines for iron and manganese were similar to the last year with Cordeaux recording the highest exceedance followed by Cataract. This is largely attributed to the corrosive water in the reticulation resulting in high rates of leaching, as well as higher metal concentrations in the source water of these two lakes. A notable manganese exceedance at Cordeaux was recorded at 0.677 mg/L, however, this was a transient concentration and water quality returned to normal levels after remedial flushing. Cataract has seen improvements in metal concentrations in the supply to drinking water fountains with point source filtration. Most metal exceedances at Cataract were recorded at the picnic area tap during periods when the potable supply was offline.

Low pH at Cataract picnic area resulted in 69% of samples below the operational target of 6.5 units (5.6-6.4 units). This is largely due to source waters and the absence of pH adjustment in the treatment process. Most of the low pH levels were reported in the supply to Cataract drinking water fountain 1 which has been turned off since March 2024 while fountain 2 is supplying water.

6 Monitoring for the Water Licences

6.1 Water quality

Sampling of downstream storages is undertaken in accordance with the requirements of the Water Licences. Table 6.1 reports the results of downstream sampling against the ANZECC benchmarks.

Table 6.1: Downstream of storages - percentage of samples exceeding benchmarks

Site	Station Code	Number of samples	pH - Field	Turbidity - Field (NTU)	Dissolved Oxygen - Field (%Sat)	Nitrogen Total (mg/L)	Phosphorus Total (mg/L)	Chlorophyll-a (ug/L)
Wingecarribee River								
Wingecarribee River @ Sheepwash Bridge	E303	12	8%	0%	33%	42%	0%	83%
Shoalhaven River								
Shoalhaven R @ d/s Tallowa Dam	E851	12	8%	0%	33%	25%	0%	50%
Woronora River								
Woronora River @ the Needles	G0515	12	17%	0%	8%	0%	0%	8%
Nepean River								
Nepean River @ Yarramundi	N44	12	25%	0%	50%	92%	25%	75%
Nepean River @ Penrith	N57	12	0%	0%	8%	83%	0%	58%

Nepean River 500m D/S of confluence of Warra R.	N64	12	0%	0%	33%	83%	8%	67%
Warragamba River U/S of confluence of Nepean R.	N641	12	0%	0%	25%	92%	0%	33%
Nepean River @ Wallacia Bridge	N67	12	0%	8%	33%	100%	25%	92%
Nepean River @ Sharpes Weir	N75	12	0%	0%	8%	100%	8%	67%
Nepean River @ Menangle Br	N85	12	0%	0%	17%	8%	0%	58%
Pheasant's Nest Weir Pool	N86	12	0%	0%	0%	0%	0%	0%
Cataract River @ Broughtons Pass	N881	12	0%	0%	0%	0%	0%	0%
Nepean River @ Maldon Weir	N92	12	25%	0%	33%	8%	0%	33%

Wingecarribee River nitrogen concentrations have decreased since last year, with 42% of samples exceeding guidelines compared with 50% of samples from last year. pH at the Sheepwash Bridge site was within targets in all samples collected, though 10 out of 12 samples exceeded the benchmark for chlorophyll a at this site.

The downstream Shoalhaven River site was accessible for sampling for the whole year. Water quality is consistent with last year with nitrogen exceeding guidelines in 3 out of 12 samples, and no phosphorus exceedances observed. Chlorophyll *a* concentrations exceeded the benchmark in 50% of samples this year.

Woronora River downstream of the storage recorded similar levels of benchmark exceedances to the previous year, with the exception of a notable reduction in pH exceedances. Turbidity, total nitrogen and total phosphorus matched last year's performance and again achieved full compliance to the benchmarks. Dissolved oxygen and chlorophyll a were both largely compliant, with only a single benchmark exceedance recorded for each analyte.

The Nepean River downstream sites exhibited similar water quality patterns to previous years, with water quality indicators generally declining with increased distance from the storages, largely due to contributions from downstream tributaries. Total nitrogen and total phosphorus compliance to benchmarks at Menangle bridge and further upstream was high, with compliance generally declining at the sites further downstream. Turbidity and pH remained largely compliant across all sites, with only a small number of exceptions recorded. Chlorophyll a compliance followed a similar pattern to the previous year, but with a further small increase in benchmark exceedances recorded for the second year running at some sites.

7 Targeted and investigative monitoring

WaterNSW undertakes targeted and investigative monitoring to understand and assess impacts that are not addressed by the routine monitoring program. The results of the monitoring are discussed in greater detail in the sections below.

A summary of water quality incidents during the reporting period is included in Section 8.

7.1 Wet weather inflow monitoring

WaterNSW conducts wet weather sampling to assist in evaluating impacts on water quality from runoff during significant rainfall events. A key component of the wet weather monitoring program is the use of autosampler stations at strategic catchment sites which are programmed to automatically take samples once a river height trigger has been reached.

Wet weather monitoring is used to quantify the water quality risks from inflows to storages. During high rainfall events, catchments are often closed to operational traffic and storages closed to boat traffic to protect the health and safety of staff and members of the public. Using autosamplers helps to acquire valuable water quality information on the water quality effects of rainfall events.

Autosamplers are programmed to collect samples for:

- total organic carbon, suspended solids, total phosphorus, total nitrogen, total aluminium, total iron and total manganese (Type 1).
- *Cryptosporidium* and *Giardia* (Type 2), plus total nitrogen, total phosphorus (site E203 only).
- Or both Type 1 and Type 2.

Where specific water quality issues have been identified, additional characteristics are analysed on request. At high priority reservoir inflow locations, both autosampler types have been installed. Given the differing sampling mechanisms, trigger values may differ between the two autosampler types. Type 2 samples are reserved for locations identified as potentially significant pathogen sources, requiring a much larger sample volume (hence the lower number of samples). Appendix B tabulates the number of samples collected from Type 1 and Type 2 autosamplers for each site during the year.

7.2 Catchment Risk Characterisation

The average pathogen risk for catchments supplying each storage lake was determined from an assessment of catchment hazards and historical water quality monitoring data based on the Health Based Targets (HBT) section of the Australian Drinking Water Guidelines (ADWG).

It is recognised that the greatest challenges to water treatment occur during heavy rain events when contaminants from the catchment and higher river flows result in poor water quality. At such times water quality monitoring is increased at raw water intakes and selected catchment and storage sites. The Pathogen Campaign Monitoring Program was instituted to enhance pathogen monitoring during high inflow events at selected catchment sites to allow the pathogen risk to be refined during events.

Cryptosporidium hazard assessment is conducted weekly and more frequently during events, to inform any decisions on potential advisory for boil water if filtration plants fail their turbidity targets. The assessments are based on a range of pathogen risk factors such as the condition

of the storages and catchments, rainfall, inflow volumes, reports of overflows from sewage treatment plants, dairy effluent ponds and stormwater overflows, and turbidity and pathogen data.

During the reporting period there were four events that triggered autosamplers at Werriberri Creek (E531) in November 2023 and January, April and June 2024, resulting in 31 samples tested for pathogens. No pathogens were detected in the January event. *Cryptosporidium* oocysts were detected in four samples with two results exceeding the minor incident threshold of 10/10 L and *Giardia* cysts were detected in 12 samples, with 10 results exceeding the minor incident threshold. Many of the other auto-samplers were triggered during the major events in but the catchments were inaccessible so samples could not be collected in time to be tested.

7.3 Macroinvertebrate monitoring

Macroinvertebrates are monitored annually under the Macroinvertebrate Monitoring Program (MMP) as a catchment health indicator across the Sydney Drinking Water Declared Catchment. In 2023, all 86 scheduled sites were sampled. The 2023 Spring AUSRIVAS sampling period coincided with the onset of drier El Nino climate conditions, in contrast to the higher rainfall and streamflow observed across the Sydney Drinking Water Catchment in the 2022 Spring sampling season. This difference in climatic conditions is likely to have contributed to recovery of macroinvertebrate populations and improved AUSRIVAS OE50 scores at many sites in 2023.

Figure 7.1 shows the distribution of 2022 and 2023 AUSRIVAS band grade ratings for each individual catchment. Of the 79 sites monitored in both 2022 and 2023, 76 received a higher AUSRIVAS score in 2023, and 3 received a lower AUSRIVAS score. This indicates a strong recovery in macroinvertebrate health across the declared catchment from 2022, although the change in OE50 score value at each site was not always large enough to result in a change of AUSRIVAS band grade.

Across the Warragamba, Tallowa, Metropolitan and Woronora catchments, most sites in 2023 were rated as below reference, and fell within the AUSRIVAS band B. Macroinvertebrate health improved in the Warragamba catchment in 2023, with 17 sites increasing by one or more band grade, and no sites decreasing in band grade. In the Tallowa catchment, 11 sites increased by one or more band grade and one site; Mongarlowe River at Charleyong (MONG1), decreased by one band grade. Across the Metropolitan catchment, one site increased by one band grade, with no change in band grade at the other sites in that catchment. One of two Woronora sites, and the Blue Mountains catchment site increased by one band grade from 2022. Further site information and site-averaged AUSRIVAS scores are presented in Table 7.1.

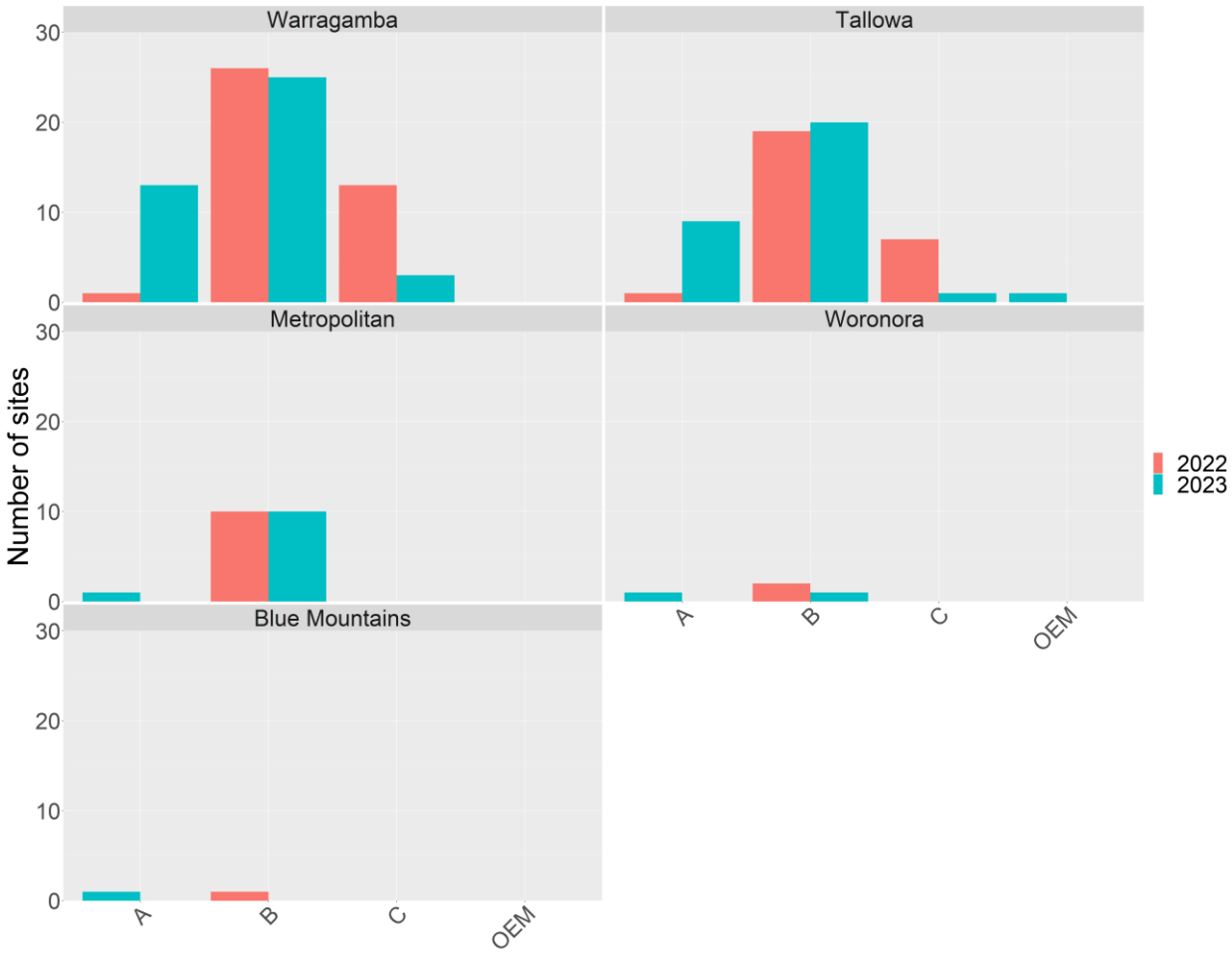

Figure 7.1: Distribution of AUSRIVAS band grades for sites monitored in 2022 and 2023. Band grades are Reference (A), Below Reference (B), Well Below Reference (C) or Outside the Experience of the Model (OEM)

Table 7.1: Mean 2023 AUSRIVAS scores, compared to 2022 results. Band grades are Reference (A), Below Reference (B), Well Below Reference (C), Outside experience of the AUSRIVAS model (OEM) or Not Sampled (NS). AUSRIVAS band thresholds are adjusted to the mean edge and riffle band value for sites where both edge and riffle habitats were sampled. *shows sites sampled within 2 weeks of high rainfall or flow events.

Sub-catchment	Site	Site Name	OE50		Band Grade	
			2022	2023	2022	2023
Warragamba (Lake Burragorang) Catchment						
Kowmung	E130	Kowmung River at Cedar Ford	0.66	0.73	B	B
Lake Burragorang	MMP59	Butchers Creek u/s of Lake Burragorang	0.56	0.65	B	B
Little River	E243	Little River at Fire Trail W4I	0.55*	0.65	B*	B
Lower Cox's	E153	Leura Falls Creek at Fire Trail W7F	0.51	0.94	B	A
Lower Cox's	E157	Kedumba River at Maxwells Crossing	0.74	0.88	B	A
Mid Cox's	E0114	Cox's River d/s Lake Lyell	0.66	0.73	B	B
Mid Cox's	E083	Cox's River at Kelpie Point	0.93	1.02	A	A
Mid Cox's	MMP276	Lowther Creek at Ecclesbourne	0.54	0.88	B	A
Mid Cox's	MMP55	Little River at Six Foot Track	0.72	1.06	B	A
Mulwaree	A5	Mulwaree River at Lake Bathurst	0.27*	0.44	C*	B
Mulwaree	E457	Mulwaree River at Towers Weir	0.54	0.82	B	A
Mulwaree	MMP188	Mulwaree River at Currawang Rd	0.33*	0.88	C*	A
Nattai	E203	Gibbergunyah Creek at Welby	0.35	0.46	C	B
Nattai	E206	Nattai River at The Crags	0.47	0.68	B	B
Nattai	E210	Nattai River at Smallwoods Crossing	0.81	0.81	B	B
Nattai	MMP277	Drapers Creek at Colo Vale Firetrail	0.36*	0.55	C*	B
Nattai	MMP278	Nattai Creek at Wombeyan Caves Rd	0.33*	0.81	C*	A
Nattai	MMP279	Nattai River d/s Mittagong pool	0.48	0.68	B	B
Upper Cox's	A16	Cox's River at Lidsdale	0.4*	0.62	C*	B
Upper Cox's	E0115	Cox's River u/s Lake Lyell	0.68	0.94	B	A
Upper Cox's	E0321	Coxs River at Lithgow	0.55*	0.88	B*	A
Upper Cox's	E046	Farmers Creek at Mount Walker	0.58*	0.68	B*	B
Upper Cox's	MMP280	Farmers Creek u/s STP at Geordie St	0.46*	0.65	C*	B
Upper Wollondilly	MMP27	Wollondilly River at Goonagulla	0.47	0.6	B	B
Upper Wollondilly	MMP281	Mount Wayo Creek at Fenwicks Creek Road	0.64	0.64	B	B
Upper Wollondilly	MMP282	Sooley Creek at Crookwell Rd	0.64	0.68	B	B
Upper Wollondilly	Uwol1	Wollondilly River at Baw Baw Bridge	0.27	0.86	C	A
Werri Berri	E531	Werriberri Creek at Werombi	0.67	0.94	B	A
Wingecarribee	E301	Caalang Creek at Maugers	0.51	0.52	B	B
Wingecarribee	MMP283	Medway Rivulet at Cosh Park	0.46*	0.77	B*	B
Wingecarribee	MMP284	Whites Creek at Cosgrove Park	0.07	0.4	C	C
Wingecarribee	MMP285	Mittagong Creek at Mount Rd	0.25	0.37	C	C
Wingecarribee	U10	Wingecarribee River at Berrima	0.32*	0.42	C*	C
Wingecarribee	Winge2	Wingecarribee River at Greenstead	0.66*	0.76	B*	B
Wollondilly	E409	Wollondilly River d/s Goulburn STP	0.5	0.7	B	B
Wollondilly	E4122	Wollondilly at Upper Tarlo	NS	0.79	NS	B

Sub-catchment	Site	Site Name	OE50		Band Grade	
			2022	2023	2022	2023
Wollondilly	E450	Wollondilly River at Golden Valley	0.48*	0.7	B*	B
Wollondilly	E488	Wollondilly River at Jooriland	0.57	0.85	B	A
Wollondilly	E5001	Wollondilly river u/s Goulburn STP	0.62	0.68	B	B
Wollondilly	MMP130	Long Swamp Creek u/s Paddys River	0.5	0.55	B	B
Wollondilly	MMP226	Tarlo River at Swallowtail Pass	0.65*	0.66	B*	B
Shoalhaven (Tallowa) Catchment						
Back and Round	MMP17	Shoalhaven River at Farringdon Crossing	NS	0.89	NS	A
Boro	E890	Boro Creek at Marlowe	0.42	0.63	C	B
Boro	MMP33	Kings Creek upstream of Boro Creek	0.65	0.93	B	A
Braidwood	E860	Shoalhaven River at Mount View	0.45	0.72	B	B
Braidwood	E891	Gillamatong Creek at Braidwood	0.43*	OEM	B*	OEM
Braidwood	MMP62	Jembaicumbene Creek at Bendoura	0.42	0.77	C	B
Bungonia	A8	Bungonia Creek at Bungonia	0.5*	0.82	B*	A
Bungonia	E847	Shoalhaven River at Fossickers Flat	0.32	0.82	C	A
Endrick	MMP12	Endrick River at Nerriga	0.47	0.61	B	B
Jerrabattagulla	MMP09	Jerrabattgulla Creek at Warragandra	0.61	0.82	B	A
Jerrabattagulla	MMP168	Jerrabattagulla Creek at Hereford Hall Rd	0.66	0.76	B	B
Jerrabattagulla	MMP273	Shoalhaven River at Wyanbene Rd	0.64*	0.8	B*	B
Jerrabattagulla	MMP67	Stoney Creek at Cooma Rd	0.47*	0.83	B*	A
Kangaroo	E300	Yarrunga Creek at Wildes Meadow	0.26	0.6	C	B
Kangaroo	E520	Bundanoon Creek at the Rocks	NS	0.84	NS	A
Kangaroo	E7021	Brogers Creek at Clinton Park	0.62	0.58	B	B
Kangaroo	E706	Kangaroo River at Hampden Bridge	0.61*	0.59	B*	B
Kangaroo	E7061	Kangaroo River at Oakdale	0.59	0.81	B	A
Mid Shoalhaven	E8311	Corang River at Meangora	0.49	0.64	B	B
Mid Shoalhaven	E861	Shoalhaven River at Hillview	0.28	0.62	C	B
Mongarlowe	E822	Mongarlowe River at Mongarlowe	0.64	0.74	B	B
Mongarlowe	MONG1	Mongarlowe River at Charleyong	0.8	0.73	A	B
Mongarlowe	R13	Mongarlowe River at Monga	NS	0.85	NS	A
Nerrimunga	E8361	Nerrimunga River at Minshull Trig	0.47	0.52	B	B
Nerrimunga	MMP51	Jacqua Creek at Lumley Road	0.38	0.73	C	B
Nerrimunga	MMP52	Nadgigomar Creek at Oallen Ford	0.32	0.4	C	C
Reedy	MMP194	Manar Creek at The Dip	0.54	0.79	B	B
Reedy	MMP258	Durran Durra Creek at Nerriga Road	0.48*	0.6	B*	B
Reedy	R7	Mulloon Creek at Tawarri	0.53*	0.72	B*	B
Reedy	REED1	Reedy Creek at Mayfield Road	0.51	0.78	B	B
Upper Shoalhaven	MMP06	Shoalhaven River at Yarra Glen	NS	0.79	NS	B
Metropolitan Catchment						
Upper Nepean	E6006	Sandy Creek inflow	NS	0.61	NS	B
Upper Nepean	E601	Nepean River at Inflow to Lake Nepean	0.66*	0.72	B*	B
Upper Nepean	E602	Burke River at inflow to Lake Nepean	0.46	0.46	B	B
Upper Nepean	E604	Flying Fox Creek No.3 u/s of gague	0.66	0.92	B	A
Upper Nepean	E608	Goondarrin Creek at Kemira 'D' cast	0.52*	0.72*	B*	B*
Upper Nepean	E609	Cataract River d/s Angles Creek	0.48*	0.6*	B*	B*
Upper Nepean	E610	Avon River at Summit Tank	0.43*	0.57	B*	B
Upper Nepean	E680	Cordeaux River b/w upper Cordeaux 1 & 2	0.53	0.78	B	B

Sub-catchment	Site	Site Name	OE50		Band Grade	
			2022	2023	2022	2023
Upper Nepean	E697	Nepean River at McGuire's Crossing	0.66*	0.8	B*	B
Upper Nepean	MMP100	Wongawilli Creek d/s of Fire Road 6	0.72	0.65*	B	B*
Upper Nepean	MMP136	Lizard Creek d/s Fire Road 8H	0.51	0.76*	B	B*
Woronora & Blue Mountains catchments						
Woronora	E677	Woronora River at Fire Road 9F	0.52*	0.78	B*	B
Woronora	E678	Waratah Rivulet at Flat Rock Crossing	0.68*	0.95	B*	A
Grose	MMP246	Woodford Creek u/s Woodford Dam	0.69	1.07	B	A

7.4 Investigative monitoring

WaterNSW's investigative monitoring program is designed to target known risks, emerging issues and inform management options. Investigative monitoring can be used for identifying pollution sources, understanding pollutant fate and transport in a variety of flow conditions and investigating the risk of pollutants reaching inflows and raw water offtake points. Investigative monitoring is also one means of evaluating the effectiveness of actions to address pollutants in the catchments and lakes.

7.4.1 Taste and odour investigation in Lake Burragorang

In August 2023, elevated concentrations of geosmin (a taste and odour compound often described as "earthy") were detected in Lake Burragorang. At the time, *D. circinale* (a known geosmin producer) was present but is usually an atypical producer of geosmin at the cell densities observed. Confirmation was required by showing the association of phytoplankton genotypes and the presence of geosmin producing genes within those genotypes. Water samples from the lake profile were collected and sent to Sydney Water Laboratory for concentration and DNA extraction. The Walter and Eliza Hall Institute performed molecular analysis to determine the likely origin of the geosmin through genetic analysis of the Cyanobacteria-specific geosmin producing gene, geoA, and Sanger sequencing to identify the taxonomy. Genetic material from geosmin-producing *Dolichospermum sp.* (e.g., *D. ucranicum, D. planctonicum, D. circinale*) was confirmed by molecular analysis at all sampled depths.

7.4.2 Water quality implications of fires in drinking water catchments

The extensive burning of the Warragamba catchment during the 2019-20 black summer bushfires highlighted the significant impact fires can have on water quality. To better understand the water quality implications of wildfires and Hazard Reduction Burns (HRBs) across the WaterNSW Special Areas, the Strategic Research and Innovation Team have been collecting ash samples following fires as they occur. The project aims to address some of the knowledge gaps that have been identified following recent research and aims to better quantify the costs and effects of HRBs and wildfires on water quality. It is envisaged that by completing this work, it will allow WaterNSW to become more proactive in terms of fire management and water quality. Early results from the limited number of fires that have occurred indicate that some macro-nutrients, such as total organic carbon, total nitrogen and total phosphorus are declining following fires. Whereas other analytes such as calcium, magnesium and hardness are increasing following fires. There are other analytes that are not showing any clear trends, and we await further opportunities to collect more samples.

8 Incidents and events

Water quality incidents are managed in accordance with the WaterNSW Water Quality Incident Response Protocol. The protocol sets out agreed water quality trigger levels for various actions and notifications. Any issue that poses a potential risk to public health is reported to NSW Health immediately and incident responses are developed in consultation with NSW Health and relevant customers.

The Water Monitoring Program also specifies monitoring required in anticipation of events which pose potential threats to raw water quality, such as large inflow events and seasonal turnover in lakes. The pre-planned monitoring during periods leading to and during such events allows operational changes to be made proactively and prevents such events manifesting into incidents.

During 2023–24, 17 major and 39 minor water quality incidents were recorded in the Greater Sydney catchment area (see Appendix C for details of these incidents).

8.1 Major and significant water quality incidents

There were seventeen major incidents relating to water quality during 2023-24. Details of all incidents and their management are provided in Appendix C. Prompt notifications and effective incident response ensured no interruptions in the supply of high quality treated drinking water to customers. Incident management responses for major and significant incidents are discussed in detail below.

8.1.1 Exceedance of Raw Water Supply Agreement site specific standards

There were eleven results outside Raw Water Supply Agreement site specific standards during the year. Four of these were due to elevated algal ASU (an indicator of filter clogging potential) in raw water supplied to Cascades Water Filtration Plant (March 2024), Kangaroo Valley Water Filtration Plant (September 2023) and Wingecarribee Water Filtration Plant (April and May 2024).

Three of the results were associated with the rainfall events that fell across the Greater Sydney catchments in April, May and June 2024. Successive inflow events across the network resulted in elevated turbidity, metals, and reduced total hardness in raw water that could not be avoided through source selection. This included elevated turbidity in the raw water supplied to Kangaroo Valley Water Filtration Plant in May 2024, elevated total aluminium in the raw water supplied to Woronora Water Filtration Plant in June 2024, and low total hardness in the raw water supplied to Macarthur Water Filtration Plant in June 2024.

There was a single total iron result outside Raw Water Supply Agreement standards for Macarthur Water Filtration Plant in March 2024 when supply options were reduced due to maintenance work closing the Nepean Tunnel. Alkalinity in the raw water supplied to Kangaroo Valley Water Filtration Plant was outside Raw Water Supply Agreement standards in December 2023 due to increasing alkalinity in source water from Lake Yarrunga.

The final two results were from the inlet to Prospect WFP in April 2024 when a sample was collected during a plant shutdown. Residual caustic dosing in the inlet channel when there was no flow impacted the results, which were not representative of the raw water being supplied.

Each instance was reported to the water filtration plant operators and supply configuration options discussed. When requested, WaterNSW provided additional raw water samples to allow the plant to perform testing to optimise treatment processes.

8.1.2 Three rainfall events in close succession

In the space of approximately two months between early April and early June 2024, the Greater Sydney catchments experienced three significant rainfall events in close succession.

The first event occurred with intense widespread rainfall over two days on the 5th and 6th of April, generating large volumes of turbid inflows. Spills were recorded at several storages, including Warragamba, Nepean, Woronora, Tallowa, and in the Blue Mountains. Storage volumes in other lakes had been depleted in the preceding months, so spills were not recorded despite receiving significant inflow volumes.

The second event consisted of less intense rainfall, but over a prolonged period. This event lasted approximately nine days from the 5th to the 13th of May, with the heaviest downpours occurring between the 11th and 13th. Spills were again recorded at many of the Greater Sydney storages with this event occurring so soon after the April event. Although peak spill rates were the lowest of the three events due to the lower intensity of the rainfall.

The third event was another intense rainfall event occurring between the 6th and 8th of June, with the heaviest rainfall coming on the 7th. Widespread rain falling on wet catchments with dams at or near capacity resulted in spills from Warragamba, Woronora, Nepean, Avon, Cataract, Cordeaux, Tallowa and in the Blue Mountains.

An incident management team (IMT) was established for the April and June events in liaison with the Bureau of Meteorology, State Emergency Services, Sydney Water and NSW Health. Water quality in the storages was significantly affected by the rainfall, with increased turbidity, organics and metals. The succession of three major events compounded these impacts. Despite these significant challenges, through proactive modelling, monitoring and source selection, WaterNSW continued to deliver best available source water to our customers to ensure safety of the water supply was not compromised.

9 References

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