Sydney Drinking Water Catchment Audit 2019 – Volume 1

WaterNSW

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Project Name	Sydney Drinking Water Catchment Audit 2019
Project Number	19SUT-12363
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Approved by	Richard Cresswell
Status	**Final**
Version Number	**5**
Last saved on	**16 June 2020**

This report should be cited as 'Eco Logical Australia 2020. *Sydney Drinking Water Catchment Audit 2019 – Volume 1*. Prepared for WaterNSW.'

Template 2.8.1

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Abbreviations

Abbreviation	Description
4YLMP	Four-year land management priorities document
ASAE	Australian Standards on Assurance Engagements
BFMC	Bushfire Management Committees
DPIE	Department of Planning, Industry and Environment
EES	Environment, Energy and Science
ELA	Eco Logical Australia Pty Ltd
EPA	Environment Protection Authority
IEPMC	Independent Expert Panel on Mining in the Catchments
IPART	Independent Pricing and Regulatory Tribunal
MoU	Memorandum of understanding
ML	Megalitres; 1 million litres (an Olympic swimming pool holds 2.5 ML)
NorBE	Neutral or beneficial effects on water quality
NPWS	National Parks and Wildlife Service
OECD	Organisation for Economic Cooperation and Developments
PSR	Pressure-State-Response
RFS	Rural Fire Service
ROC	Rivers of Carbon
SASPoM	Special Areas Strategic Plan of Management
SEED	Sharing and Enabling Environmental Data
STP	Sewage Treatment Plant

To the Minister for Water, Property and Housing

Dear Minister

The independent audit team is pleased to present the 2019 Sydney Drinking Water Catchment Audit report in three volumes. The audit report is intended for tabling in Parliament, as required under section 42 of the *Water NSW Act 2014*.

The audit provides scientifically-based information about the health of the Sydney Drinking Water Catchment during the period 1 July 2016 to 30 June 2019. The audit team has assessed the state of the declared Catchment, having regard to the catchment health indicators approved under section 41 of the *Water NSW Act 2014*. The indicators relate to water quality, water availability, biodiversity and habitats, and land use and human settlements.

The audit report has been developed in consultation with the community, local councils and NSW Government agencies such as WaterNSW, Local Land Services, the Environment Protection Authority and the Department of Planning, Industry and Environment. The audit team has collected, reviewed and analysed data available for the audit period and longer term, and conducted site inspections to determine:

- What are the main hazards to catchment health?
- Have the risks to catchment health been decreasing, increasing or similar?
- What future responses are needed to address the risks to the Catchment?

The audit also outlines changes that have occurred since the first catchment audit in 1999.

The audit concludes that, despite substantial improvements in catchment management since 1999, overall risks to catchment health are increasing because of climate change. Monitoring records since the 1940s indicate a long-term trend of reduced rainfall. The drought experienced over the audit period reduced water availability (surface and groundwater flows) across the Catchment and increased risks to water quality, biodiversity and human settlements.

Other key findings of the 2019 audit include:

- **Pollution** - Overall Catchment water quality was similar to historic trends. Further improvement will be needed in most sub-catchments to consistently achieve water quality benchmark guidelines. Priority areas for improvement are the Upper Coxs River and Wingecarribee River sub-catchments, which have multiple pressures associated with past and present coal mining, and industrial and urban activities.
- **Water availability** – Surface and groundwater resources are not being sustainably managed, particularly in the context of climate change. More than half (52%) of the surface water monitoring stations had reduced streamflow levels compared to the long term. Insufficient groundwater monitoring is contributing to the uncertainty about sustainable use of groundwater resources.
- **Natural areas, wetlands and riparian corridors** – Areas of native vegetation contribute positively to the health of the Catchment. However, there is insufficient data to determine if the extent and integrity of natural areas, wetlands and riparian corridors have been maintained,

reduced or improved since the previous audit. Extensive weed control continues to be undertaken in Wingecarribee Swamp to improve its condition.

- **Fire** – Bushfire Risk Management Plans need to be updated to better recognise and reduce the risks to natural assets and water quality, including Strategic Fire Advantage Zones principles to protect water storages.
- **Community engagement** - Collaboration and knowledge-sharing by public and private land managers in programs such as the Rural Landscape Program and Rivers of Carbon are enhancing landscapes in the Catchment through revegetation, weed control and erosion management, as well as contributing to the social fabric of rural communities.
- **Data adequacy and availability** – Every catchment audit since 1999 has raised concern about the inadequate availability and quality of data to assess catchment health indicators. It was encouraging to find that an increasing number of agencies are sharing datasets, which will support improved evaluation and decision-making.

Similar with previous audits, the primary issue of concern raised by the community related to environmental impacts from coal mining within the Special Areas of the Catchment. The community provided positive responses to the appointment of the Independent Expert Panel on Mining in the Catchment in 2018. The community also expressed support for jointly funded programs to protect and improve riparian corridors through weed and erosion control, revegetation and managing stormwater.

Recommendations from the audit are grouped under the following themes, with the overall objective to mitigate the consequences of climate change and increase the resilience of catchment health by reducing threats and strengthening the integrity of natural systems:

- Pollution - reduce pollutant loads discharged to Catchment waterways
- Water availability - sustainably manage surface and groundwater resources
- Natural areas, wetlands and riparian corridors - continue to maintain or improve the integrity of protective landscape barriers throughout the Catchment
- Fire - reduce risk of inappropriate fire regimes
- Community engagement - improve land management in collaboration with landholders and the community
- Data adequacy and availability - improve monitoring and datasets as a basis for good decision making and management.

The Audit has formed recommendations considering the current tools and programs available to the NSW Government. Most responses involve more effective and coordinated use of existing agency programs, policies and legislation. The responses have been reviewed by the relevant public authorities and are considered feasible for implementation.

We commend this audit report to the Minister for tabling in the NSW Parliament.

On behalf of the audit team:

Beth Medway
Project Manager, 2019 Sydney Catchment Audit

1. Introduction

The quality and quantity of Sydney's water supply is directly related to the health of the declared Sydney Drinking Water Catchment ('the Catchment'). Regular audits of the health of the Catchment have been conducted since 1999 using multiple social and environmental indicators. Recommendations from each audit have informed governmental and societal responses to issues arising.

Eco Logical Australia (ELA) has been engaged under Section 42 of the *Water NSW Act 2014* on behalf of the Minister for Water, Property and Housing as the auditor for the period 1 July 2016 to 30 June 2019.

The 2019 audit report is structured as follows:

- Volume 1 – Catchment overview and concepts, audit method, key findings and recommendations
- Volume 2 – Analysis of each indicator with case studies
- Volume 3 – Appendices to support analysis in Volume 2.

The audit was conducted as a limited assurance engagement in accordance with the Australian Standards on Assurance Engagements (ASAE), 3000 Assurance Engagements other than Audits or Reviews of Historical Financial Information and ASAE 3100 Compliance Assurance Engagements. The ASAEs set out mandatory requirements on ethical practice, audit planning, conduct, quality control and reporting.

We thank all contributors for their cooperation and assistance during the audit.

2. Features and purpose of the Catchment

2.1 What is the Sydney Drinking Water Catchment?

The declared Sydney catchment area ('the Catchment') is defined in Clause 17 of Schedule 2 of the *Water NSW Act 2014* and covers parts of the hydrologic catchments of the Hawkesbury–Nepean, Shoalhaven and Woronora Rivers. The Catchment extends over 16,000 km^2 (Figure 1) from:

- north of Lithgow on the Coxs River
- the head of the Shoalhaven River in the south near Cooma
- Woronora River in the east
- the source of the Wollondilly River west of Goulburn.

It includes Prospect Reservoir in western Sydney.

The Catchment comprises an inner catchment area and outer catchment area:

- The inner catchment is within the Special Areas (Warragamba, Metropolitan, Woronora, Blue Mountains (Blackheath, Katoomba and Woodford), Shoalhaven, Fitzroy Falls and Wingecarribee) and the hydrological catchment of Prospect Reservoir.
- The outer catchment is within the hydrological catchments of the Warragamba Riv tributaries which drain to Lake Burragorang; the Shoalhaven River and its tributaries w to Lake Yarrunga; and Greaves, Whipcord, Woodford and Cascades Creeks, but excl inner catchment area described above.

Major drainage systems and topography across the Catchment are indicated in Figure 2. To varies from approximately 1460 m elevation above sea level in the Blue Mountains ar Mountains to 20 m elevation around some of the storages.

The Catchment is characterised by six major river systems - Blue Mountains, Shoalhaven, Uppe Warragamba, Woronora and Prospect Reservoir (mapped in Figure 1). The Shoalha Warragamba are the largest river systems, with 12 sub-catchments each, whereas the Blue M Prospect Reservoir, Upper Nepean and Woronora have one sub-catchment each, as indicate 1 and Figure 3.

The sub-catchments drain into dams that store 'raw water', which has not yet been treated fo water purposes. Table 1 lists raw water storages in the Catchment and indicates if they are ma WaterNSW or a local council. Raw water is also extracted directly from the Shoalhaven Queanbeyan-Palerang Regional Council to supply Braidwood, and the Wollondilly River by Goulburn Mulwaree Council to supply Goulburn and Marulan.

The Catchment also features public and privately managed weirs, including major weirs at Broughtons Pass (Wilton) and Pheasants Nest (Appin) that are managed by WaterNSW.

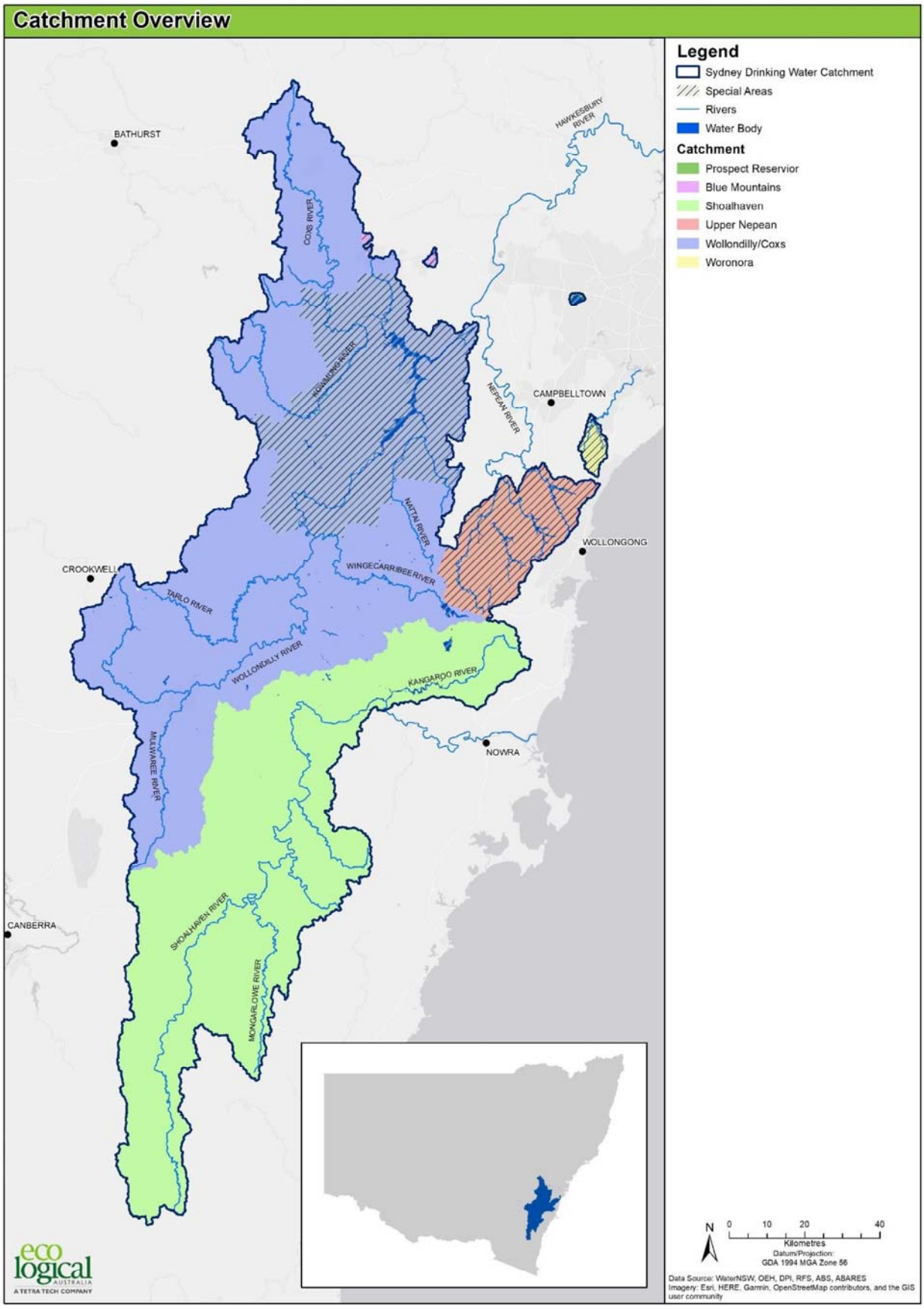

Figure 1: Sydney Drinking Water Catchment overview

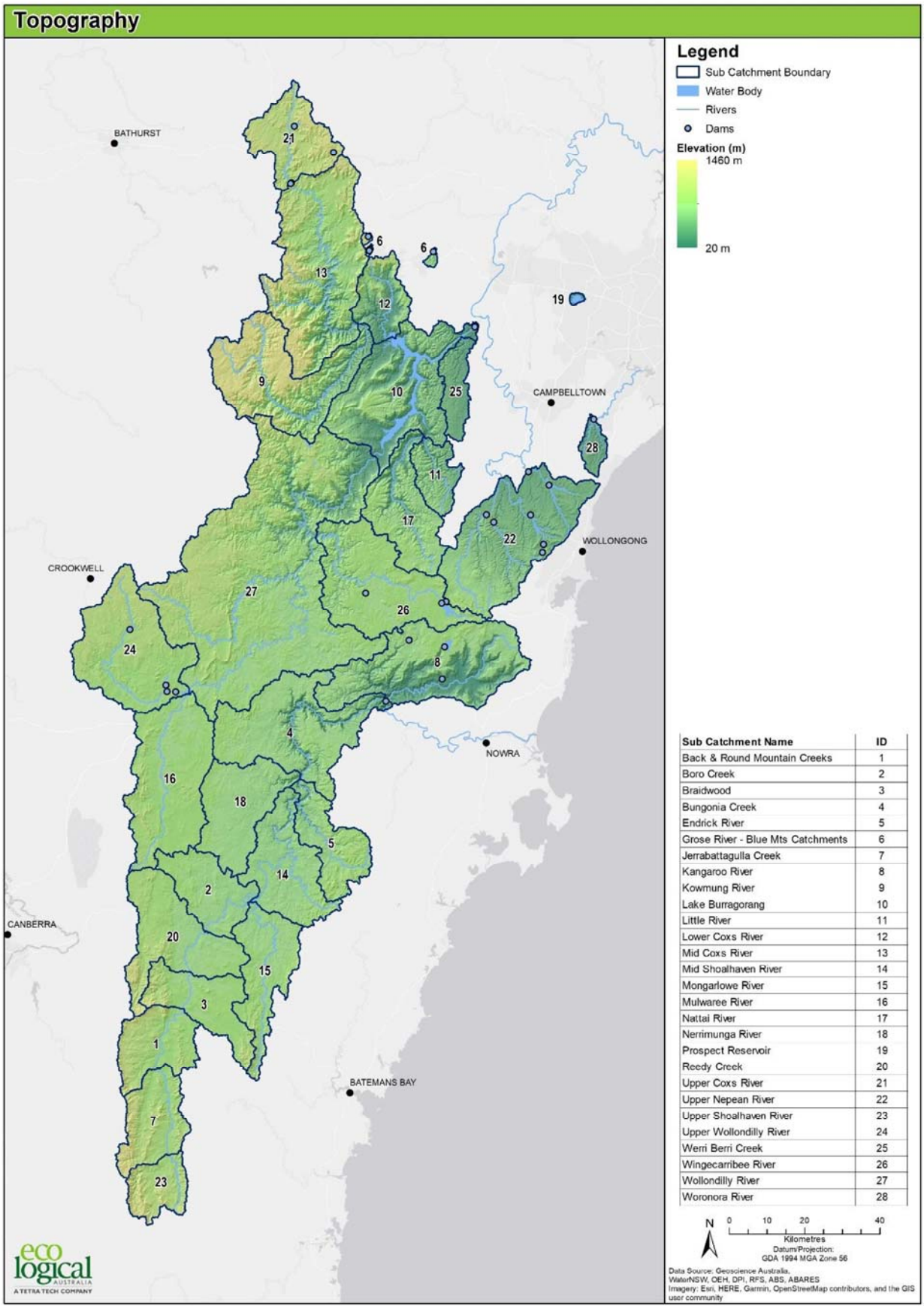

Figure 2: Topography

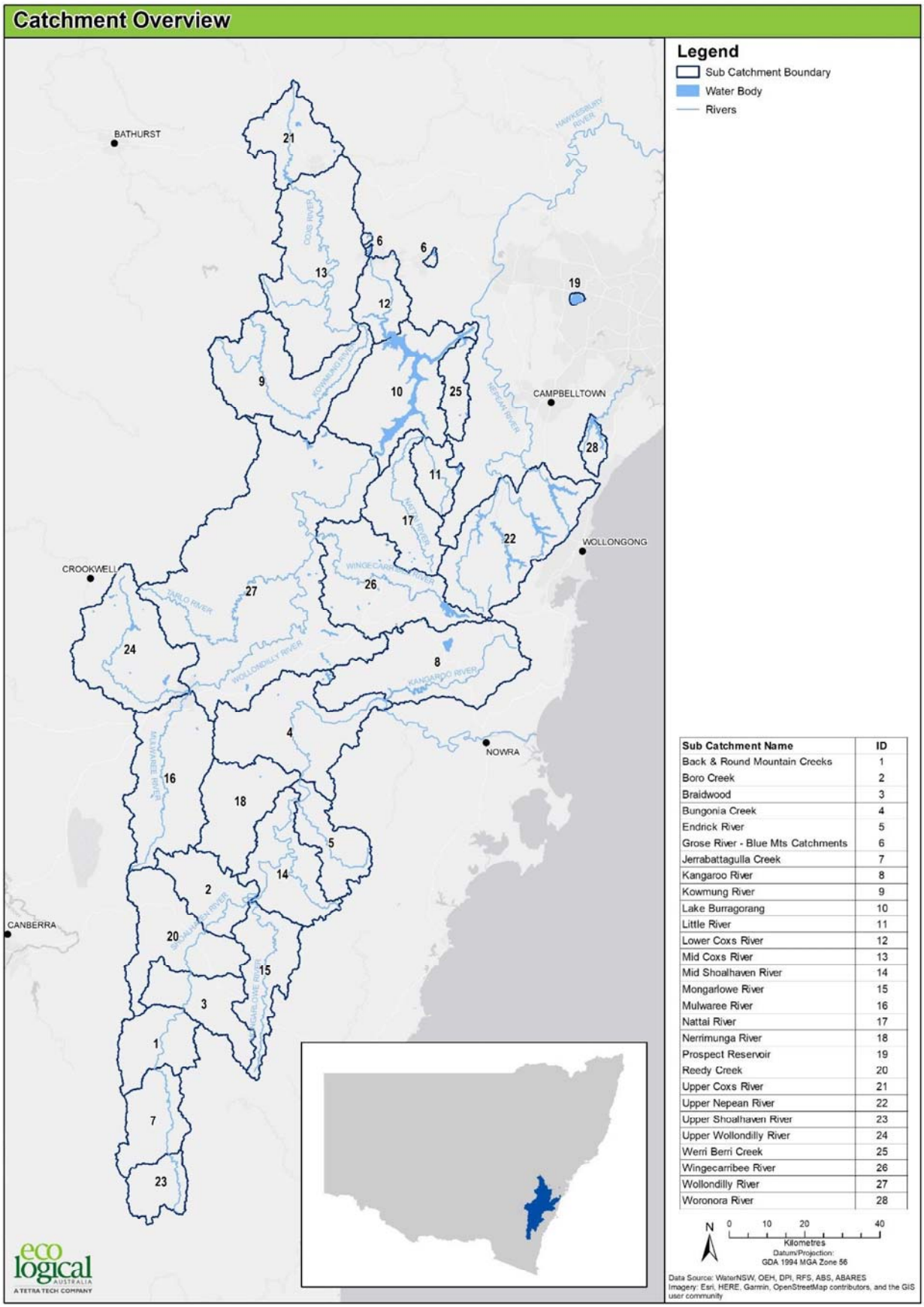

Figure 3: Sub-catchments and major rivers

Table 1: Major river systems, sub-catchments, and storages

ID#	Sub-catchment	Major river system	Raw water storage*
1	Black & Round Mountain Creek	Shoalhaven	
2	Boro Creek	Shoalhaven	
3	Braidwood	Shoalhaven	
4	Bungonia Creek	Shoalhaven	Lake Yarrunga
5	Endrick River	Shoalhaven	
6	Grose River	Blue Mountains	
7	Jerrabattagulla Creek	Shoalhaven	
8	Kangaroo River	Shoalhaven	Fitzroy Falls Dam, Lake Yarrunga *Bundanoon Creek Dam*
9	Kowmung River	Warragamba	
10	Lake Burragorang	Warragamba	Lake Burragorang
11	Little River	Warragamba	Lake Burragorang
12	Lower Coxs River	Warragamba	Lake Burragorang
13	Mid Coxs River	Warragamba	
14	Mid Shoalhaven River	Warragamba	
15	Mongarlowe River	Shoalhaven	
16	Mulwaree River	Shoalhaven	
17	Nattai River	Warragamba	
18	Nerrimunga River	Warragamba	
19	Prospect Reservoir	Prospect Reservoir	Prospect Reservoir
20	Reedy Creek	Shoalhaven	
21	Upper Coxs River	Shoalhaven	*Farmers Creek Dam*
22	Upper Nepean River	Warragamba	Avon Dam, Cataract Dam, Cordeaux Dam, Nepean Dam, Upper Cordeaux Dam, Wingecarribee Dam
23	Upper Shoalhaven River	Upper Nepean	
24	Upper Wollondilly River	Shoalhaven	*Pejar Dam* *Sooley Dam*
25	Werri Berri Creek	Warragamba	Lake Burragorang
26	Wingecarribee River	Warragamba	Wingecarribee Dam
27	Wollondilly River	Warragamba	Lake Burragorang
28	Woronora River	Woronora (also referred to as Metropolitan)	Woronora Dam

Identification for sub-catchments used in maps throughout this audit report

*Italicised raw water storages are managed by local councils rather than WaterNSW

2.2 Purpose of the Catchment

2.2.1 Multi barrier approach

The Catchment collects and stores up to 2.6 million ML of water from private and public land to supply Sydney, the Blue Mountains, the Illawarra, the Southern Highlands and parts of the Shoalhaven area. The management of drinking water quality in the Catchment follows a multiple barrier approach consistent with the Australian Drinking Water Guidelines 2011. It includes:

- monitoring and influencing land uses, developments and activities across the Catchment
- establishing, maintaining and managing Special Areas and Controlled Areas around water storages and water supply infrastructure, where human access or certain activities are restricted (refer to section 2.2.2 for further information)
- reservoir management
- water treatment and distribution.

The strength of the multiple barrier approach is that a failure of one barrier may be compensated by effective operation of the remaining barriers, thereby minimising the likelihood of contaminants passing through the entire treatment system and being present in sufficient amounts to cause harm to consumers.

Catchment management is the first barrier for the protection of water quality and availability. By decreasing contamination of the source water, the level of water treatment required (and associated costs and risks) can be reduced.

2.2.2 Special Areas

The Special Areas within the Catchment are identified in Figure 1 and are an important part of the multi-barrier approach. They cover approximately 3,640 km^2 and comprise mostly bushland and natural landscapes around the water storages and water supply infrastructure. There are three categories of access in the Special Areas, as tabulated below. Public access and activities are restricted in the Special Areas, although restrictions do not apply to privately owned land and public roads, and there are coal mining leases in the Special Areas.

Table 2: Special Areas

Category	Description
Special Areas – no entry	These areas include the water storages and surrounding land except Fitzroy Falls Reservoir and part of Lake Yarrunga, which are classed as restricted entry.
Controlled Areas – no entry	These areas include the land at Warragamba protecting the water supply infrastructure and the land along the Warragamba Pipelines and Upper Canal.
Special Areas – restricted entry	These areas include the water storages and surrounding land of Fitzroy Falls Reservoir and part of Lake Yarrunga, and the second protection zone around Lake Burragorang. Vehicles (including motorcycles and bicycles), horses, pets, powered watercraft and firearms are not allowed.

The current Special Areas Strategic Plan of Management (SASPoM) was prepared in 2015 in accordance with section 52 of the *Water NSW Act 2014* and adopted by the 'joint sponsors', the Minister for the Environment and the Minister for Water, represented through the agencies of WaterNSW and the National Parks and Wildlife Service (NPWS). The SASPoM is scheduled for review every five years.

Land management priorities under the SASPoM are developed by the joint sponsors using statutory instruments, operations plans and policies within the joint sponsor organisations, external research, subject matter expertise, information on emerging issues and field observations. Agreed priorities for the Special Areas are presented in a four-year land management priorities (4YLMP) document and reviewed by the joint managers annually to allow for change in priority issues or land management interventions.

Work programs under the SASPoM are approved individually by the joint sponsor agencies and can be approved for any time period depending on the agency. The 4YLMP are considered by the agencies when developing their individual work programs. Examples of work program activity under the SASPoM in 2018-19 include:

- Pest animals: Pest control targeting pigs, goats, deer, cattle and other priority species linked to impacts on riparian zones, wetlands and swamps.
- Weeds: Weeds with greatest risk to impact riparian zones, wetlands and swamps targeted (e.g. Alligator Weed, Water Hyacinth, Willow).
- Fire: Coordinated approach to fire management via District Bushfire Management Committees; preparedness to suppress wildfire and implement approved agency fire management program in accordance with hazard reduction plans.
- Roads and trails: Maintain access routes to ensure activities can be undertaken with a priority to fire, land and water management.
- Access management: Access management in line with statutory requirements of Water NSW Act and Regulation.
- Recreation facilities: Managed to protect amenity, visitor safety and water quality, including remote toilet program.

In addition to the SASPoM work programs, WaterNSW funds the NPWS for water quality works on an annual basis under a Land Management Program service level agreement.

2.3 Roles and responsibilities in the Catchment

Organisations and landholders that share responsibility for management of the Catchment are involved in implementation of on-ground works; development and application of legislation, policies and guidelines; and monitoring for compliance and adaptive improvements. Roles of relevant public authorities are outlined below. The most notable difference since the 2016 audit is that there are now two overarching NSW Government departments directly relevant to management of the Catchment:

- NSW Department of Planning, Industry and Environment (DPIE), which includes (amongst others) the following in its portfolio:
  - Environment, Energy and Science
  - Planning and Assessment
  - Regions, Industry, Agriculture and Resources

  - Water
- NSW Department of Customer Service, which includes the:
  - Independent Pricing and Regulatory Tribunal

2.3.1 Environment, Energy and Science

DPIE's Environment, Energy and Science group includes the:

- Environment Protection Authority (EPA)
- National Parks and Wildlife Service (NPWS)
- Policy, Strategy and Science Division – Water, Wetlands and Coastal Science Directorate

EPA

The EPA regulates activities scheduled under the *Protection of Environment Operations Act 1997* and enforces environmental regulations through licensing, monitoring and auditing. The EPA applies a risk-based approach to help manage potential water pollution impacts associated with development. The EPA responds to major pollution incidents and can impose fines, stricter operating conditions, or clean up orders.

The EPA shares information and partners with other authorities to regulate activities impacting on water quality in the Catchment. It contributes to the planning process through the provision of advice and conditions for the development approval process. It considers water quality data to identify possible sources of pollution (e.g. salinity) and the relative contributions from licensed premises to further refine where regulatory effort can be focused.

Under a Memorandum of Understanding (MoU), WaterNSW and the EPA have agreed to work together in carrying out their respective functions to prevent, avoid, reduce or mitigate the effects of pollution events in the Catchment and on water quality. The purpose of this MoU is to encourage effective interaction between the parties, the exchange of information, and to form the basis for effective and cooperative relationships to further the objectives of each organisation in catchment protection. WaterNSW and the EPA maintain a strategic liaison group comprising senior representatives of each agency to ensure strategic matters relating to this MoU are dealt with.

NPWS

The NPWS has diverse responsibilities across the catchment, including to:

- Conserve and care for national parks and reserves, biodiversity and threatened species.
- Promote, protect and share Aboriginal culture and heritage in partnership with Aboriginal people and local communities.
- Conserve, revitalise, care for the historic heritage within the catchment.
- Support economic development by promoting sustainable industries, tourism in protected areas, jobs and access to natural resources without devaluing the environment.
- Advise, support and educate communities, regions, industry and landholders on the environment and heritage.
- Help communities and businesses build resilience to climate change, environmental hazards and risks.

- Develop and lead reforms in biodiversity, native vegetation, Aboriginal, non-Aboriginal and shared heritage, energy efficiency, air and water quality, coastal protection and sustainability.
- Jointly manage the Special Areas with WaterNSW.

2.3.2 Planning and assessment

DPIE's Planning and Assessment group is responsible for environmental planning and assessment, and compliance monitoring and enforcement in accordance with the *Environmental Planning and Assessment Act 1979.* This includes management of the policies and approvals processes for developments such as mining, agricultural enterprises and major urban areas.

2.3.3 Water

DPIE's Water group manages surface and groundwater in NSW, develops and implements plans for water security, and manages regional and metropolitan water supply and usage. The Water group includes WaterNSW and the Natural Resources Access Regulator (NRAR).

WATERNSW

WaterNSW is a state-owned corporation established under the *Water NSW Act 2014.* It operates under an Operating Licence issued and monitored by the Independent Pricing and Regulatory Tribunal (IPART). A principal objective of WaterNSW under the Act is 'to ensure that declared catchment areas and water management works in such areas are managed and protected so as to promote water quality, the protection of public health and public safety, and the protection of the environment'. Functions of WaterNSW stated in section 7 of the Act that are relevant to the declared catchment include to:

- protect and enhance the quality and quantity of water in declared catchment areas
- manage and protect declared catchment areas and water management works vested in or under the control of WaterNSW that are used within or for the purposes of such areas
- undertake research on catchments generally, and in particular on the health of declared catchment areas.

WaterNSW promotes protection of water quality across the Catchment through its statutory role in development and land use planning instruments, as well as through its compliance functions established under the *Water NSW Act 2014*, the *Protection of the Environment Operations Act 1997* and the Water NSW Regulation 2013 in relation to potentially polluting activities and incidents. WaterNSW also protects water quality in the Catchment through management of its own land holdings and the Special Areas.

Section 43 of the *Water NSW Act 2014* states that WaterNSW must evaluate the findings of the catchment audit to the extent to which they relate to the activities of WaterNSW and risks to water quality in the Catchment. It states also that WaterNSW must incorporate the findings of the catchment audit, to the extent to which they relate to the activities of WaterNSW and water quality, into WaterNSW's risk framework, programs and activities relating to Catchment management. Section 44 of the Act states that WaterNSW must report to the Minister on WaterNSW's progress to achieve improvements in catchment health, to prevent degradation of existing catchment health and to maintain existing catchment health, having regard to the findings of the audit.

2.3.4 Regions, Industry, Agriculture and Resources

This group includes the NSW Department of Primary Industries (DPI) and Local Land Services (LLS). DPI regulates biosecurity, fisheries, plantation forestry, and hunting for game and pest animal species. There are three LLS regions within the Catchment (Greater Sydney, Central Tablelands and South East) and these connect people with groups, information, support and funding to improve agricultural productivity and better manage natural resources.

This group also includes the Resources Regulator, which was established in 2016 and is responsible for regulation, compliance and enforcement for mining and mining exploration activities. The Resources Regulator has a key role in overseeing mine rehabilitation.

2.3.5 Independent Pricing and Regulatory Tribunal

IPART is within the NSW Department of Customer Service. IPART is the independent regulator that determines the prices that can be charged for certain retail water services in New South Wales. IPART also serves as the NSW Government's economic advisor. IPART oversees compliance with the operating licence for WaterNSW.

2.3.6 Local Councils

The 14 local councils and their communities continue to play an important role in catchment management. Key council roles are as follows:

- A regulator under the *Protection of the Environment Operations Act 1997*
- A land-use planner using the *Environmental Planning and Assessment Act 1979*
- An operator responsible for the management of infrastructure, such as urban stormwater systems, some limited sewerage services, and some councils collect, store, treat and distribute drinking water.

In January 2011, the NSW Government approved State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 which requires consent authorities must not grant consent to the carrying out of development unless it is satisfied that the carrying out of the proposed development would have a neutral or beneficial effect (NorBE) on water quality.

3. Audit scope and process

3.1 What is the scope of the Catchment Audit?

The terms of reference for the 2019 Catchment Audit are:

- The catchment audit is required to assess the state of the Catchment having regard to the catchment health indicators approved under section 41 of the *Water NSW Act* and in force at the time of assessment. The four themes and 18 indicators are listed in Table 3 below.
- The catchment audit is to be conducted having regard to the current methodology used in the State of Environment reporting for NSW. (Refer to section 3.3 for an overview of the Pressure – State – Response framework used in this audit, consistent with NSW State of Environment reporting.)
- Consultation must be undertaken with stakeholders inside and outside the Catchment to seek information and data that may assist with the audit and to seek comments relating to the state of the Catchment. (Refer to section 3.3 for an overview of the consultation method.)
- The audit is to cover the period from 1 July 2016 to 30 June 2019.

Table 3: Indicators of catchment health

Theme	Indicators
Land use and human settlements	Community attitudes, aspirations and engagement Population settlements and patterns Land use Sites of pollution and potential contamination Soil erosion
Water quality	Ecosystem and raw water quality Nutrient load Cyanobacterial blooms
Water availability	Surface water flow Environmental flows Groundwater availability
Biodiversity and habitats	Macroinvertebrates Fish Riparian vegetation Native vegetation Fire Wetlands Physical form

3.2 Key questions for the audit

The audit team will aim to answer, using the data available for the audit period and longer term:

- What are the main hazards or potential sources of harm to catchment health?
- Have the risks to catchment health been decreasing, increasing or similar?
- What future responses are needed to address the risks to the Catchment?

The audit also reviews changes that have occurred since the first catchment audit in 1999.

3.3 Evaluation framework

The audit methodology is based on the internationally accepted Pressure-State-Response (PSR) framework, which was initially developed by the Organisation for Economic Cooperation and Developments (OECD) and is used for State of Environment reporting (e.g. Department of Environment and Energy 2017 and NSW EPA 2018). The PSR model provides a structure that links environmental policies to environmental monitoring and reporting (OECD 1993). The model considers that: human activities exert pressures on the environment and affect its quality and the quantity of natural resources ('state'); society responds to these changes through environmental, general economic and sectoral policies and through changes in awareness and behaviour ('response').

The PSR *framework* highlights cause-effect relationships, and helps decision makers and the public see environmental, economic, and social issues as inter-connected. This helps to select and organise indicators of the state of the environment in a way that is useful for decision-makers and the public.

In this audit, as illustrated in Figure 4, the pressures are related to land use and human settlement (and related indicators), the state of the Catchment is revealed by the primary indicators of water quality and availability and complementary indicators of biodiversity and habitats. The response part of the PSR model refers to the extent to which society responds to the state and pressures. Response refers to individual and collective actions intended to:

- mitigate, adapt to or prevent human-induced negative effects on the environment
- halt or reverse environmental damage already inflicted
- preserve and conserve nature and natural resources.

Existing and future responses may aim to achieve behavioural changes, or preventative and reactionary catchment management responses focussed on damage control and rehabilitation. Examples include education programs, grants and incentive schemes, planning controls and policies, and legislation. In general, a greater or changed response will be required if the state is poor and pressures are increasing.

A changed response is recommended by the auditor to reduce the risk to catchment health where there is a worsening trend and / or poor state, as indicated in the decision matrix below (Table 4). In other cases, the existing response should be maintained so that there is no increase in the risk to catchment health.

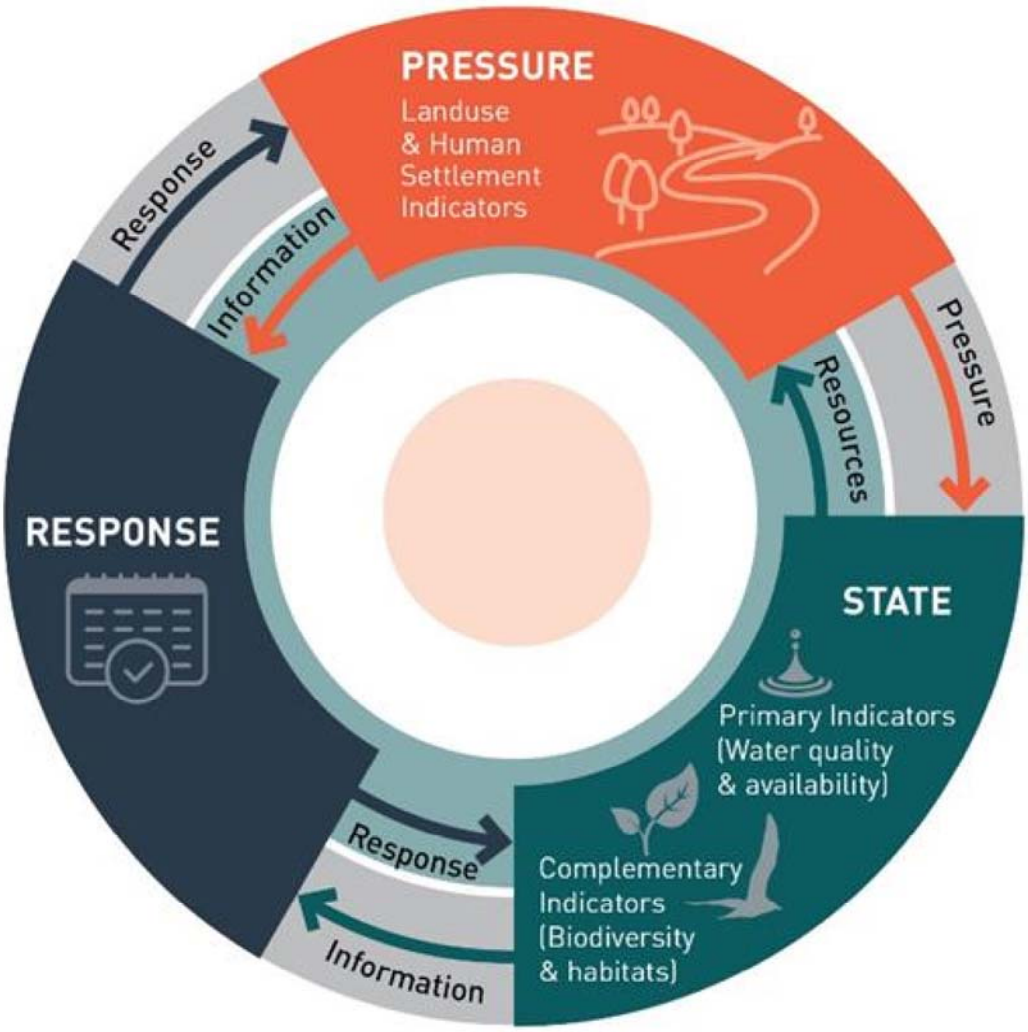

Figure 4: Pressure – State – Response model (adapted from OECD 1993)

Table 4: Pressure – State – Response decision matrix

		Trend The indicator trend describes the direction of significant change in condition and is generally judged over the reporting period, between the previous audit report and the current report. The trend reported, using the descriptors below, may have an impact on the overall status of the indicator in the future.		
		Improving	**Stable**	**Worsening**
State Indicator status refers to the condition of the indicator over the reporting period.		The trend in condition for the indicator is getting better (impacts are decreasing)	No significant change for indicator	The trend in condition for the indicator is getting worse
Good	The data shows a positive or healthy condition	**Maintain response**	**Maintain response**	**Change response**
Moderate	The data shows that the condition is neither good nor poor, or results may be mixed across the Catchment	**Maintain response**	**Maintain response**	**Change response**
Poor	The data indicates poor condition or condition under significant stress	**Change response**	**Change response**	**Change response**
Unknown	Insufficient data to make an assessment			

Based on NSW State of Environment nomenclature

3.4 Consultation

The audit report was developed from desktop review, field inspections and stakeholder consultation. Elements of the consultation are outlined in Table 5, with details in Volume 3 Appendix B.

Table 5: Overview of consultation

Consultation method	Purpose	Description
Letters to known government and non-government stakeholders Media advertisements	Notification of the audit Request submissions and information	Letters were sent to 68 organisations Notices were published in State and Local media and in the National Indigenous Times
Direct contact including phone calls, emails and meetings	To follow-up the initial requests for data and information	All contacts were followed-up; many multiple times with different individuals in the organisation
Site visits	Targeted site inspections were used to gain greater appreciation of the issues and effectiveness of management actions taken during the audit period.	11 December 2019 – Blue Mountains and Lithgow water sensitive urban design; mine discharge at Wangcol Creek; Coxs River swamps; Lake Wallace 23 January 2020 – Renwick residential subdivision; Wingecarribee Swamp; water sensitive urban design for commercial enterprises in Moss Vale; Bong Bong Common Rivercare 20 February 2020 – Rural Landscape Program sites: 'Throsby Park' at Moss Vale, 'Innus Park' at Parkesbourne and 'Little Vale' at Goulburn
Meetings with selected authorities with responsibility for implementation of actions	Review proposed recommendations	DPIE - WaterNSW DPIE - Water DPIE - EES DPIE - EPA DPIE - Planning & Assessment DPIE - LLS Wingecarribee Shire Council

4. Response to the 2016 audit

Legislative and financial responsibility for addressing the key findings of each audit resides with public authorities, although only WaterNSW is obligated to report on progress. This chapter summarises the agency responses to the 2016 audit, which have previously been reported to the Minister. Outstanding matters have been reviewed by the auditor and, if still relevant, incorporated in the recommendations of the current audit.

Section 44 of the *Water NSW Act* requires WaterNSW to report to the Minister on progress to achieve improvements in catchment health, to prevent degradation of existing catchment health and to maintain existing catchment health, having regard to the findings of the audit. The 2016 Catchment Audit report was presented to the Minister in July 2017 and covers the period 1 July 2013 to 30 June 2016. The following summarises progress in response to the key findings of the 2016 audit.

4.1 Mining in Special Areas

2016 Audit Finding and Recommended Responses: The Audit found an emerging issue of unquantified loss of surface flows associated with the cumulative impacts of underground coal mining activities. This issue required attention to be considered in implementation of the Metropolitan Water Plan and activation of licencing under Section 60I of the *Water Management Act 2000* and in accordance with the NSW Aquifer Interference Policy. Greater understanding of the effect of multiple mine workings on Catchment water yield was required, and this understanding reflected in relevant mine planning, appropriate water licencing and the regulation of those licences.

WaterNSW Progress: WaterNSW has been working with several stakeholders to improve understanding of the volumes of surface water being diverted from the Special Area by mining. In 2018, in collaboration with Dr Paul Tammetta (a leading groundwater hydrologist), WaterNSW completed an assessment of two independent methods aimed at calculating water losses in undermined catchments. This research report (Tammetta 2018) was peer-reviewed by a UNSW academic and provided promising results but required further analysis to reduce the considerable uncertainties. The Independent Expert Panel for Mining in the Catchment (IEPMC), formed partly in response to the 2016 Catchment Audit, completed its Final Report in late 2019 and recommended that WaterNSW 'continue its program of work towards determining the significance for the Greater Sydney water supply of different thresholds of surface water loss due to mining'.

As such, WaterNSW has been focusing on implementing both assessment methods to quantify cumulative impacts incurred by both longwall and pillar extraction mining in the Metropolitan and Woronora Special Areas. The results of this assessment are close to being finalised and will be subject to peer review and review by the IEPMC.

Until this work is finalised, it is noted that the IEPMC found that there is no evidence that mining in the Special Areas is currently compromising the ability for WaterNSW to meet raw water supply and quality standards. Nevertheless, it concluded that the upper limit of mining-related losses across the Special Areas is an average of 8 ML/day, of which Dendrobium Mine alone is less than 5 ML/day, and Metropolitan Mine is negligible, with an average of 0.09 ML/day. The IEPMC notes that 8 ML/day

compares to the Sydney Desalination Plant capacity of approximately 250 ML/day, and estimated leaks from the Greater Sydney supply infrastructure of approximately 130 ML/day.

The IEPMC followed on from the findings of the 2016 audit and recommended that the NSW Government establish a regulatory regime to license surface water losses in the Special Areas. There is currently no legal mechanism available under the *Water Management Act 2000* for a mining company operating in the Special Areas to acquire a licence for surface water 'take'. This is a problem for historical and existing mining operations in the Special Areas as they are unable to comply with the water legislation. The NSW Government has recently announced it will establish of a regulatory regime to address this issue. WaterNSW is part of a Government taskforce to identify the best options and submit a report for Ministerial approval.

On a day to day basis, WaterNSW will continue to closely examine and interrogate estimation methodologies and results submitted by mining companies in impact predictions and results, which are largely being performed by a combination of groundwater and rainfall-runoff modelling.

Progress by other agencies: In November 2017 the NSW Government established the IEPMC to provide expert advice to the (then) Department of Planning and Environment, now the Department of Planning, Industry and Environment, on the impact of mining activities in the Greater Sydney Water Catchment Special Areas, with a particular focus on the risks to the quantity of water in the Catchment.

The Panel submitted its Final Reports in September 2019, focusing particularly on activities at the Dendrobium and Metropolitan coal mines, having regard to other relevant studies and reports, including the Height of Cracking – Dendrobium Area 3B (PSM study) and the 2016 Audit of the Sydney Drinking Water Catchment (2016 Catchment Audit) reports. A separate report was prepared to review developments since the 2008 Southern Coalfield Inquiry as well as risks to water quantity, in particular addressing environmental consequences for swamps, cumulative impacts and measures to improve the way mining effects, impacts and consequences in relation to water quantity are assessed and managed.

4.2 Land degradation

2016 Audit Finding and Recommended Responses: The audit found continued decline in water quality in the Wingecarribee, Braidwood, Wollondilly, Mulwaree, Upper Wollondilly and Nattai River sub-catchments caused largely by soil erosion and gullying. This decline was attributed to land management practices that result in overgrazing and uncontrolled stock access to riparian zones. Further work was required with landholders to reduce land degradation and associated impacts to receiving storages.

WaterNSW Progress: WaterNSW continued to have active programs seeking to reverse land degradation resulting from overgrazing and uncontrolled stock access to riparian zones (including all the identified sub-catchments). In the past four years WaterNSW has added the team from Rivers of Carbon (ROC) to the South East Local Land Services to work on this issue. The addition of ROC has extended the reach of the program through active use of online and social media resources. Since 2017 the partnership has produced a series of resources including Buffers, Sponges and Moderators film and Stock and Waterways: A NSW Managers Guide.

WaterNSW partnerships have resulted in:

- 105 farms participating in projects to actively control grazing and exclude stock from waterways

- Over 13,000 web views of new online resources and over 350 copies of Stock and Waterways ordered by land/farm managers
- Provision of over $3.3M in funding to assist with on farm improvements and promotion of best practices leading to an estimated $8M expenditure on on-ground improvements
- These programs have excluded stock from 187 km of riparian zones and improved grazing practices on over 4675 ha in the Catchment.

WaterNSW intends to continue its partnerships with ROC and the South East Local Land Services and is seeking new partners to extend the reach of its grazing and erosion control program.

4.3 Sewerage infrastructure

2016 Audit Finding and Recommended Responses: There was evidence that upgrades to sewage treatment infrastructure have been successful in decreasing nutrient loads and improving raw water quality supplied to storages. Compared to the previous audit period, there was a reduction in nutrient loads discharged to waterways near sewage treatment plants at Wallerawang, Lithgow, Bundanoon, Goulburn and Bowral. Upgrades to Lithgow STP resulted in notable improvement to Farmers Creek, with no cyanobacteria alerts issued at this site in the 2016 audit period. In comparison, this site had 27 red alerts during the previous audit period. However, there was evidence that some sewage treatment plants were at capacity and continued investment in sewerage infrastructure required to keep risks to inflow water quality at an acceptable level. Priority was given to upgrading the Bowral, Moss Vale and Mittagong sewage treatment plants.

WaterNSW Progress: WaterNSW provided substantial funds to assist in the upgrade of the sewage treatment plants at Wallerawang, Lithgow, Bundanoon, Goulburn and Bowral resulting in the improvements reported above. In 2019, Goulburn Mulwaree Council completed a substantial upgrade of the Goulburn Sewage Treatment Plant. WaterNSW established a before and after water quality monitoring program to assess the impact of this upgrade, as the effluent disposal system changed from land application to direct waterway discharge. In addition, more recently WaterNSW has been and will continue working with the EPA and Wingecarribee Shire Council aimed at upgrades of the Bowral, Moss Vale and Mittagong sewage treatment plants to provide for population growth and to ensure there is a neutral or beneficial effect on water quality. Wingecarribee Shire Council has provided substantial funds in its forward four-year budget to fund these upgrades.

Progress by other agencies: Responsibility for requiring upgrades to sewerage infrastructure where there are environmental pollution issues resides with the Environment Protection Authority (EPA) and delivery is the responsibility of local councils. Sydney Water also has sewerage infrastructure within the Catchment in the Blue Mountains (Mt Victoria, Blackheath, Medlow Bath, Katoomba, Leura and Wentworth Falls) and Wollondilly (The Oaks, Oakdale, Belimbla Park and Buxton). The infrastructure comprises pipes and pumping stations. It is important that this infrastructure is maintained and operated in accordance with the relevant EPLs.

The EPA is working with Wingecarribee Shire Council on the upgrades of sewage treatment plants (STPs) in the Wingecarribee LGA in response to previous audits. Sewerage infrastructure upgrade projects are in varying stages of investigation and design, in collaboration with the Public Works Advisory. Further work is being undertaken to upgrade sewerage infrastructure in the Catchment.

4.4 Bushfire risk

2016 Audit Finding and Recommended Responses: Risks of bushfire and associated impacts on water supply are increasing due to climate change and expansion of urban areas within the Catchment. Bushfire increases flow variability and sediment and nutrient runoff. An improved fire planning and burning management response, including updated and implemented Bushfire Risk Management Plans was suggested to mitigate these risks to the Catchment and water supply assets.

WaterNSW Progress: The *Rural Fires Act 1997* governs bushfire management in NSW. Rural Fire Service (RFS) are the lead fire authority for bushfire planning and co-ordination in NSW. Fire management affects a range of land owners, agencies and the community. To be effective, fire management must have coordinated planning and implementation to achieved landscape scale objectives for protecting life and property and the environment. This co-ordination is primarily undertaken through District Bushfire Management Committees (BFMC) which areas are loosely based on local government boundaries. BMFC have representation from key fire and land management agencies (RFS, NSW Fire & Rescue, NPWS and Crown Lands for example) and landowner, utilities and mining managers.

The BFMC forum led by the RFS undertakes regional scale fire planning and co-ordinates emergency fire response and fire mitigation. This includes preparation and revision of the district bushfire risk plan which identifies fire advantage assets and the key risk sites in the district as well the mitigation and response measures to best protect these. Proposed hazard reduction burning programs are tabled at the BFMC forum and from these a strategic hazard reduction burning program for the district is coordinated and approved for implementation.

The BFMC is the key strategic forum to have WaterNSW priority risks and hazard reduction burning program endorsed for implementation to protect water quality. Due to the importance of BFMC to water quality management from fire impact WaterNSW has representation on nine strategically situated Bushfire Management Committees in the declared Sydney catchment area providing input and strategic influence to their District Bushfire Risk Management Plans and strategic hazard reduction burning programs.

As a land owner and public authority under *Rural Fires Act 1997* WaterNSW must prevent the occurrence of bushfire on land under its control or management and minimise the danger of a bushfire spreading from its land. To give effect to this WaterNSW has fire management strategies developed to plan and implement through the BFMC process mitigation strategy including mechanical vegetation slashing and hazard reduction burning. WaterNSW also maintains a strategic bushfire trails network to allow fire management and response actions on WaterNSW lands.

WaterNSW has a strong interest in managing fire in the Special Areas for protection of water quality values as a significant component in the multiple barrier approach under the drinking water guidelines. Drinking water protection is achieved by working with NPWS to deliver on outcomes agreed in the Special Area Strategic Plan of Management (SASPoM). WaterNSW works with NPWS and RFS to respond to fire including:

- target fire management works with specifically identified service levels
- liaison and co-ordination of fire under joint management

- provision of a rapid response firefighting team to respond to the outbreak of wild fires within timeframes dependent of the fire danger index.

4.5 Data quality and monitoring

2016 Audit Finding and Recommended Responses: The inadequate availability and quality of data and monitoring has been raised in previous audits and remained a concern. Several data sets for indicator measures were not updated since the 2013 audit (e.g. native vegetation, stream physical form) which restricted audit analysis. A number of recommendations were made in the 2016 Audit to improve data quality and monitoring as a basis for informed decision-making.

WaterNSW Progress: WaterNSW has a comprehensive surface water quality and quantity monitoring program throughout the Catchment. The program is maintained and data generated is available to key stakeholders. WaterNSW publishes annual water quality monitoring reports. 44 of 46 routine water quality monitoring sites in the Catchment have now been integrated into the macroinvertebrate monitoring program. The remaining two routine monitoring sites were considered unsuitable for habitat for long-term macroinvertebrate monitoring. The first round of sampling under the revised program was completed in December 2019. WaterNSW provides water data to the Office of Environment and Heritage for input to the NSW Sharing and Enabling Environmental Data (SEED) data base for access by everyone.

WaterNSW has analysed the historical water quality data for streams in each sub catchment and derived values, using the ANZECC approach. This has confirmed the feasibility of this approach. It is noted that there are some limitations in the derived values and how they should be used in the declared catchment, this is being further explored. Locality specific guideline values for streams were deemed appropriate and have been developed. Methodology for storages have been developed but not applied due to complexities involved.

WaterNSW has a program of interventions that will improve catchment water quality. Intervention programs are implemented with monitoring and evaluation programs established to assess the effectiveness of the implemented programs.

WaterNSW has agreed to locate DPIE-Water groundwater monitoring bores on its land at several locations. These bore audits have almost been completed and monitoring has commenced. WaterNSW is assisting DPIE-Water with the provision of information to assist the Department in updates to data sets on stream physical form.

5. Key findings and responses

5.1 Historical context

The first audit of the Catchment was conducted in 1999 in accordance with the *Sydney Water Catchment Management Act 1998.* The 1999 audit guided the newly formed Sydney Catchment Authority (SCA) in its role to protect and enhance Sydney's hydrological catchments. The SCA was created in response to recommendations from the 1998 Commission of Inquiry into contamination of Sydney's drinking water (the McClellan Inquiry). In 2014, the SCA merged with the former State Water to form WaterNSW under the *Water NSW Act 2014*.

This chapter examines changes since the first catchment audit in 1999. It also summarises the key findings of the 2019 audit to inform future action.

5.1.1 Key findings of the 1999 audit

The CSIRO 1999 audit made the following key findings:

- A range of land uses within the headwater and upper catchments of the Coxs, Nepean, Nattai, Wingecarribee, Mulwarree, Wollondilly, Kangaroo and Shoalhaven River systems increased the hazards for both water quality and catchment health. These hazards derived from the extraction of water from the catchment and river systems and most importantly, the management of wastes and effluents. The specific pollution hazards were sewage effluent and biosolids from sewage treatment plants, unsewered villages, and unsewered periurban and rural smallholdings.
- Many of these same headwater catchments were under high levels of hydrological stress, particularly during periods of low flow and high demand. This stress, in concert with other impacts of land use and management, degraded many headwater and upper catchment aquatic ecosystems to the extent that their ability to ameliorate and assimilate pollutants and toxins was seriously compromised.
- Hazards to water quality and catchment health in the Mulwarree, Wollondilly, Kangaroo and Shoalhaven catchments included urban and peri-urban development. However, the primary hazards in these catchments derived from the impact of animal grazing with stock access to streams, the large number of unsealed roads and tracks, intensive pig and poultry enterprises, meat and wool processing, and damaged riparian zone, coupled with extensive gully and sheet erosion.
- Many of the risks to water quality within the Catchment came from existing development. However, legislation outside the mandate of the (former) SCA could override catchment management regulation. Thus, land uses inconsistent with drinking water quality and catchment health were expected to flourish in the Sydney Water Supply catchments unless SCA had the legislative capacity and institutional arrangements to deal with existing and future development. This was the primary threat to both water quality and catchment health.
- The behaviour of microbial pathogens, in particular viral pathogens, in the continuum from source(s) to treatment plant within the Sydney catchments, was not well understood. While there had been work detecting Cryptosporidium and Giardia in the Catchment, there was minimal information on the behaviour and survival of the different pathogens under different

environmental conditions. It was essential that any data used to improve the understanding of pathogen behaviour in the Sydney catchments was relevant to the environmental and climatic conditions of these catchments. Until these facts were properly understood, risk assessment and management decisions about pathogens in the Catchment could not be undertaken properly.

- There were large gaps in data on mines, both old and new, the status of their rehabilitation and their impact on the environment. This was largely due to poor collaboration between Government departments with different priorities.
- Diffuse sources of sediment and nutrients in the outer catchments, especially degraded riparian zones, unsealed roads and stock watering points, gully and sheet erosion, were a high priority for mitigation.

5.1.2 Responses since 1999

The SCA / WaterNSW and others with significant roles in managing the Catchment have introduced and implemented a range of initiatives to improve catchment health over the past 20 years, including the following:

- Transition from a focus on the Special Areas to protect water quality, to a whole of catchment approach.
- Implementation of new systems, risk assessments, plans to protect water quality and catchment health, and more comprehensive monitoring activities including the:
  - Special Areas Strategic Plan of Management
  - WaterNSW Water Quality Management System developed consistent with the Australian Drinking Water Guidelines
  - Catchment to Customer risk assessments which are done on a regular basis and in collaboration between WaterNSW, NSW Health and Sydney Water
  - WaterNSW catchment-wide water quality monitoring system which provides for regular and ad hoc monitoring (the latter in response to incidents and instances of elevated readings).
- Implementation of regulatory reforms including:
  - Regional and state planning controls to protect water quality – the current being the State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011. This SEPP contains the granting of concurrence powers for development applications to WaterNSW, the neutral or beneficial effects on water quality (NorBE) test and a requirement for development and activities to incorporate WaterNSW's current recommended practices and standards.
  - Ministerial Planning Direction (5.2 – Sydney Drinking Water Catchment) requiring new local environmental plans (LEPs) and amendments to LEPs to be prepared in accordance with the general principle that water quality in the Catchment must be protected (and other specific principles). The Direction also requires certain zoning of lands within the Special Areas – which has been done – and includes a requirement for councils to consult with WaterNSW when preparing new LEPs or amendments to LEPs.
  - The gazettal of new LEPs and adoption of development control plans (DCPs) that have a recognition of the importance of protecting water quality including more appropriate zonings, matters for consideration and development standards.

  - The regulatory framework for the approval and management of on-site sewage systems, which requires a more onerous procedure to gain approvals for new systems than outside the Catchment and approvals to operate systems.
  - Two extensive inquiries into mining in the Special Areas resulting in the regulatory framework for mining changing, including considerably more robust assessment processes, greater limits on mining, increased monitoring requirements and improved compliance activities.
  - The regulatory powers under the *Protection of the Environment Operations Act 1997* granted to WaterNSW – currently contained in the Water NSW Regulation 2013, which provide for WaterNSW to be an Appropriate Regulatory Authority in certain circumstances.
  - The large increase in species, communities and threatening processes listed under Commonwealth and State legislation and the associated assessment and approval processes.
  - Inclusion of a large part of the Warragamba catchment on the World Heritage Register with the creation of the Greater Blue Mountains World Heritage Area, and subsequent provisions of the *Environment Protection and Biodiversity Conservation Act 1999* that apply.
- Implementation of a range of measures which either removed or reduced pollutant sources including:
  - Upgrades of and new sewerage systems by councils including at Lithgow, Wallerawang, Bowral, Robertson, Kangaroo Valley, Goulburn, Taralga and Braidwood. WaterNSW provided substantial funds towards these upgrades. This included new and upgraded STPs and improvements to reticulation systems (such as relining of pipes and upgrades to pumping stations).
  - Sydney Water's upgrades, expansions and decommissioning works at various sewerage systems including the sewering of The Oaks, Belimbla Park, Oakdale, Buxton, and Medlow Bath (with transfer of wastewater out of the catchment for treatment and disposal); the decommissioning of the Mt Victoria STP (with transfer of wastewater out of the catchment for treatment and disposal).
  - Water quality control measures required for new developments including wetlands, bioretention systems, raingardens and other proprietary stormwater quality improvement devices.
  - WaterNSW's Rural Landscape Program and similar catchment management programs implemented over the last 20 years including grazing and erosion control program, stormwater management program, dairy management program, rural roads sealing programs, the derelict mines rehabilitation program and the on-site sewage program.
  - Removal of pollution hot spots such as stock saleyards at Goulburn and Moss Vale (closing down or addition of roofing), the decommissioning of the Wallerawang Power Station, and the sealing of Main Road 92 traversing the Endrick River and Bungonia Creek sub catchments.
  - An ongoing moratorium on biosolids disposal from Sydney Water STPs in the Catchment.
  - Regulatory action by the EPA to further limit pollutant concentrations and loads from licenced premises.
- An increase in land area in the Catchment reserved under the *National Parks and Wildlife Act 1974*, which added to the total area of protective landscape barriers.

- Minimal population growth thereby limiting the impacts on the Catchment from growth.
- Increased community and landholder participation in land and waterway protection activities such as Landcare, Bushcare, Rivercare and Rivers of Carbon.
- Workshops and training for council staff, consultants and the general population undertaken by a range of parties including WaterNSW (e.g. stormwater training and NorBE training).
- The introduction of environmental levies imposed by some councils which provided funds aimed at improving catchment health (as evidenced by the auditor during inspections in the Blue Mountains and Wingecarribee local government areas).
- Development and implementation of a range of best management practices targeted at protecting water quality and maintaining and improving the catchment by a range of government, industry and interest groups. This includes the Current Recommended Practices of WaterNSW adopted pursuant to SEPP (Sydney Drinking Water Catchment) 2011.

5.2 Key findings of the 2019 audit

Actions taken by government, industry and the community since 1999 have reduced many hazards within the Catchment, however, further action is needed to improve catchment health and resilience. The available evidence for the 2016-19 audit period indicates that the main pressures on catchment health are climate change, mining, urban stormwater and sewage pollution, vegetation clearing and degradation, and poorly managed stock grazing. Key findings are summarised as follows:

- **Climate change** - The health of the Catchment is under increasing pressure due to climate change. There is a long-term trend of reduced rainfall across the Catchment based on monitoring records since the 1940s and the drought experienced over the audit period further reduced water availability (surface and groundwater flows). Reduced surface and groundwater availability increased threats to water quality (including increased numbers of cyanobacterial alerts), human settlements (water supply) and biodiversity (e.g. drying wetlands and riparian corridors, and less habitat for fish and macroinvertebrates).
- **Pollution** - Overall water quality across the Catchment was similar to historic trends, with very few sub-catchments experiencing very good (e.g. Little River sub-catchment) or very poor (e.g. Boro Creek sub-catchment) water quality. Improvements have been recorded in locations where pollutant loads have decreased (e.g. due to sewerage infrastructure upgrades), and further improvement is needed in most sub-catchments to consistently achieve water quality benchmark guidelines. Priority areas for improvement are the Upper Coxs River and Wingecarribee River sub-catchments, which have multiple pressures associated with past and present mining, industrial and urban activities.
- **Water availability** - Surface and groundwater resources are not being sustainably managed, particularly in the context of climate change. Just over half (52%) of the surface water monitoring stations had substantially reduced streamflow levels compared to the long term. Insufficient groundwater monitoring is contributing to the uncertainty about sustainable use of groundwater resources.
- **Natural areas, wetlands and riparian corridors** – The Catchment features areas of native vegetation, wetlands and vegetated riparian corridors, which contribute positively to the health of the Catchment, not just in the Special Areas. There is insufficient data to determine if the

extent and integrity of natural areas have been maintained since the previous audit. Extensive weed control continues to be undertaken in Wingecarribee Swamp to improve its condition.

- **Fire** – Incomplete data available to the auditors meant that it was not possible to determine long term fire trends in the Catchment. Bushfire Risk Management Plans are available for six zones in the Catchment and two (Cumberland and Macarthur) require updating. Climate conditions experienced prior to and during the audit period contributed to the heightened risk of fire that occurred in the summer of 2019/20.
- **Community engagement** - Collaboration and knowledge-sharing by land managers in programs such as the Rural Landscape Program, Rivers of Carbon, Landcare and Bushcare are enhancing landscapes in the Catchment through revegetation, weed control and erosion management, as well as contributing to the social fabric of communities.
- **Data adequacy and availability** – Every catchment audit since 1999 (including the current audit) has raised concern about the inadequate availability and quality of data and monitoring to assess catchment health indicators. A notable recent improvement is the NSW Sharing and Enabling Environmental Data (SEED), which contains datasets that are publicly accessible. It was encouraging to find that an increasing number of agencies are sharing datasets, which will support improved decision-making.

Similar to previous audits, the primary issue of concern raised by the community (and discussed in Volume 3 Appendix B) relates to environmental impacts from coal mining within the Catchment, particularly in the Special Areas which have restricted public access. The community provided positive responses to the appointment of the Independent Expert Panel on Mining in the Catchment (IEPMC) in 2018 and expressed support for jointly funded programs to manage urban stormwater runoff and improve riparian corridors through weed and erosion control and revegetation.

5.3 Recommended responses

There is a need to mitigate the consequences of climate change and increase the resilience of catchment health. This can be achieved by reducing threats such as sources of pollution and strengthening the integrity of natural systems. Recommended responses to the key findings have been developed in consultation with relevant agencies and are tabulated below with links to additional information in Volumes 2 and 3.

Table 6: Audit recommendations

Ref	Action	Timing	Responsibility	Support	Summary justification and link to more information
A	**Pollution - reduce pollutant loads discharged to Catchment waterways**				
A1	Finalise investigations to support upgrades to sewerage infrastructure in the Wingecarribee LGA (Wingecarribee River and Nattai River sub-catchments). Undertake upgrades to sewerage infrastructure based on the outcomes of investigations.	2020-22	Wingecarribee Shire Council	EPA	Previous upgrades to sewerage infrastructure in the Catchment have improved stream water quality. For example, water quality in Farmers Creek improved following the Lithgow sewage treatment plant upgrade (Vol. 2 s.9.3). Upgrading sewerage infrastructure in Wingecarribee LGA is a priority due to the existing infrastructure reaching capacity as population increases (Vol. 2 s.5.4.1).
A2	Undertake strategic investigations of cumulative environmental impacts in the Upper Coxs River and Wingecarribee River sub-catchments, including: • identify major past, present and reasonably foreseeable sources of water pollutants in the sub-catchments, including diffuse sources • review the adequacy of measures to protect water quality and aquatic ecosystems and human health in the sub-catchments, now and in the future • develop options to reduce high numbers of cyanobacterial alerts at Lake Wallace and Lake Lyell (in the Upper Coxs sub-catchment) and Wingecarribee Lake (in the Wingecarribee sub-catchment) • review the obligations and capacity of EPA licenced activities in the Upper Coxs and Wingecarribee sub-catchments to address water quality and aquatic ecosystem concerns if current requirements as assessed as inadequate • review the obligations and capacity of polluting industries in the Upper Coxs and Wingecarribee sub-catchments to undertake rehabilitation and	2021	WaterNSW	EPA Resources Regulator Energy Australia DPIE - EES - Science Division	Monitoring of multiple indicators in these two sub-catchments raised matters that would benefit from further investigation. Compared to other areas in the Catchment, the Upper Coxs River and Wingecarribee River sub-catchments have relatively high numbers of Environment Protection Licences (EPLs) and known contaminated sites (Vol. 2 s.5.3). EPL sites are monitored, but the data is not in a format that can be easily integrated with WaterNSW water quality monitoring results for streams and storages (Vol. 2 s.7). There is only one WaterNSW water quality monitoring station in the Upper Coxs sub-catchment (Vol. 2 s.7.3), and this is positioned upstream of most pollutant sources. There were relatively high numbers of cyanobacterial alerts in storages in the Upper Coxs River and Wingecarribee River sub-catchments (Vol. 2 s.9.4 and Vol. 3 Appendix D). Macro-inverebrate monitoring found that 100% of samples from the Upper Coxs River and 25% of samples from Wingecarribee River were outside the experience of the Australian River Assessment System model (Vol. 2 s.15.3). Evidence indicates ongoing, strong community concern about environmental impacts within the Upper Coxs River and Wingecarribee River sub-catchments (Vol. 2 s.2.3), including impacts to wetlands (Vol. 2 s.19). (Also Vol. 3 Appendix B.)

Ref	Action	Timing	Responsibility	Support	Summary justification and link to more information
	restoration works and identify options if current requirements are assessed as inadequate • consider the role of water transfers and dam depth on water quality and supply • consider the context of a changing climate • develop and implement programs to address the outcomes of the investigations above.				Multiple indicators were affected by drought conditions during the audit period, which is part of a long-term trend of reduced rainfall in the Catchment as the climate changes (Vol. 2 s.1.2).
A3	Investigate the reason for very poor Dissolved Oxygen, Turbidity and Total Aluminium results in streams in the Boro Creek sub-catchment (station E890).	2021	WaterNSW	DPIE – EES – Science Division LLS	Water quality monitoring results for the Boro Creek sub-catchment are presented in Vol. 2 s.7.3 and Vol. 3 Appendix C.
A4	Undertake an audit of neutral or beneficial effect (NorBE) related consent / approval conditions for a range of development types.	2021	DPIE - Planning	WaterNSW EPA	Certain types of proposed development in the Catchment need to satisfy the NorBE test as part of the approval process. Monitoring data are not available to demonstrate that approved developments are having a NorBE on water quality. Urban stormwater management case studies investigated by the auditor (Vol. 2 s.5.4.4) found that there can be substantial effort at the planning and approval phase of development to consider NorBE, but there is little evidence of compliance activity to ensure approval conditions aimed at achieving a NorBE on water quality are being correctly implemented at both the construction and operational stages.
B	**Water availability - sustainably manage surface and groundwater resources**				
B1	Implement the recommendations from the Audit of the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011 (Alluvium and Vista Advisory 2019), as relevant to the Catchment. Review the long-term average annual extraction limit and adjust in the context of climate change.	2020	DPIE - Water		Sustainable use of surface water resources needs to allow for the long-term trend of declining rainfall across the Catchment (Vol. 2 s.1.2) and associated reduced streamflow (Vol. 2 s.10.3).

Ref	Action	Timing	Responsibility	Support	Summary justification and link to more information
B2	Review and update the Water Sharing Plans for the Greater Metropolitan Region Unregulated River Water Sources 2011 and the Greater Metropolitan Region Groundwater Sources 2011. This should include review and revision of surface water / groundwater interactions, with an assessment of the consequences of the (likely) higher proportion of total licensed groundwater entitlement and basic landholder rights of the long-term average annual extraction limits.	2021	DPIE - Water	NSW Natural Resources Commission	The NSW Government has scheduled reviews of the Water Sharing Plans for rivers and groundwater sources. Analysis of surface water and groundwater availability during the audit period indicated the need for improved understanding of conditions and interactions to ensure sustainable use (Vol. 2 s.10 & 12; Vol. 3 Appendix E).
B3	Consider, as part of the scheduled review of the Metropolitan Water Plan, the option of managed aquifer recharge within the Catchment.	2022	DPIE - Water	WaterNSW Sydney Water	Increasing water supply demand together with a decreasing rainfall trend (Vol. 2 s.1.2) means that alternative approaches will need to be considered if we are to sustain catchment health and groundwater levels (Vol. 2 s.12; Vol. 3 Appendix E).
B4	Review the obligations and capacity of mines in the Catchment to undertake rehabilitation and restoration works.	2021	Resources Regulator		Mining impacts catchment health, especially in the Special Areas. For example through oil spill incidents (Vol. 2 s.5.4.2) and impacts to wetlands (Vol. 2 s.19.4). Areas impacted by mining will need to be rehabilitated as mines are progressively closed. The Berrima Colliery is an example of good rehabilitation (Vol. 2 s.5.4.6). Community confidence in the capacity of mining companies to rehabilitate impacts, however, is low (Vol. 2 s.2.3 and Vol. 3 Appendix B).
B5	Consistent with the recommendations from the IEPMC: • Establish an inter-agency working group to identify acceptable levels of surface water loss due to mining in the Catchment after considering the significance of different thresholds of surface water loss due to mining in the Catchment • Establish performance measures related to changes in groundwater pressure and/or pressure gradients where these have the potential to impact on surface water diversions or losses for all future mine approvals in the Special Areas • Investigate and quantify the potential impacts of historic and current mining for long-term	2020	DPIE – Planning & Assessment	Inter-agency Taskforce	The IEPMC was established partly in response to recommendations from the 2016 Catchment Audit. Some of the related issues that were raised in the previous audit and continue to be raised by the community (Vol. 2 s.2.3 and Vol.3 Appendix B) regarding mining in the Catchment have been considered by the IEPMC and require further investigation.

Ref	Action	Timing	Responsibility	Support	Summary justification and link to more information
	cumulative impacts on water quantity and quality in the Special Areas, for the purpose of properly informing mine design, offsets, mine rehabilitation and closure planning, planning assessments and rehabilitation bonds (see related recommendation B4).				
B6	Ensure sufficient water entitlements are retained by all mines operating in the Special Areas to cover potential surface water losses resulting from mining induced effects, including predicted climate change impacts.	Ongoing	DPIE - Water		As with recommendation B5 above, potential surface water loss due to mining in the Special Areas has been raised in previous audits and continues to be a concern (Vol. 2 s.10 & 19.4). Less water availability due to long term climate trends (Vol. 2 s.1.2) provides further context to this issue.
C	**Natural areas, wetlands and riparian corridors - continue to maintain or improve the integrity of protective landscape barriers**				
C1	Continue joint management of the Special Areas in accordance with the scheduled update of the Special Areas Strategic Plan of Management and long-term land management programs.	2020	WaterNSW NPWS		Management of the Special Areas improves catchment health by controlling pests, weeds and erosion, and restricting access (Vol. 1 s.2.2.2). Evidence of the effectiveness of this approach is given in the consistently good water quality results of the Little River sub-catchment (Vo. 2 s. 7.3).
C2	Protect the ecological values of Wingecarribee Swamp through: • continued weed control and implementation of the Wingecarribee Swamp Operations Plan (noting that weed control effort and funding should reduce to a maintenance level over time) • repair or replace fences adjacent to stocked land, especially on the higher risk areas on the northern side of the swamp.	Ongoing	WaterNSW		Wingecarribee Swamp supports water supply for the Southern Highlands (Vol. 2 s.11). Ongoing management has aimed to retain its important natural heritage values (Vol. 2 s.19.3) after it partially collapsed into Wingecarribee Reservoir in 1998.
C3	Undertake strategic risk assessment for all swamp types in the Catchment to prioritise protection or restoration and identify swamps that may be vulnerable to existing or future development.	2020	DPIE - EES	DPIE - Water	Wetlands assist with water storage and flood mitigation, and provide a sink for sediments, nutrients and other pollutants mobilised from the Catchment. Rock fracturing, groundwater drawdown and stormwater runoff associated with longwall mining and urbanisation have resulted in a decline in the extent and condition of wetlands in

Ref	Action	Timing	Responsibility	Support	Summary justification and link to more information
					some areas of the Catchment. Although some restoration efforts have occurred, the scale and success have been disproportionately low compared to the long-term impacts documented in the Catchment. (Vol. 2 s.19.6)
D	**Fire - reduce risk of inappropriate fire regimes**				
D1	Review and update all Bushfire Risk Management Plans relevant to the Catchment to better recognise and reduce the risks to natural assets and water quality. Apply Strategic Fire Advantage Zones principles to protect water storages.	2021	BFRMCs	RFS	Existing BFRMPs focus on protection of human life and property. The role of the Catchment as a natural asset to supply Sydney's drinking water needs greater consideration in the BFRMPs, especially in the context of increasing fire risk associated with climate change (longer fire season, greater potential frequency and intensity of fires), and the potential threat to water supply from sediment and ash in runoff. (Vol. 2 s.13)
E	**Community engagement - improve land management in collaboration with landholders & the community**				
E1	Continue to evaluate the effectiveness of weed control, erosion control, revegetation and riparian zone protection programs to inform future strategies.	Ongoing	LLS	WaterNSW	Natural resource management activities such as Bushcare, Landcare, the Rural Landscapes Program and Rivers of Carbon have positive benefits for catchment health and the community and require ongoing evaluation for continuous improvement. (Vol. 2 s.2.4, 16.5 & 17.5)
E2	Continue to work with councils to improve stormwater management.	Ongoing	WaterNSW	LLS	WaterNSW has supported stormwater management programs in selected councils and has established an internal benchmarking tool to measure improvements (Vol. 2 s.5.4.4).
F	**Data adequacy and availability - improve monitoring and datasets as a basis for good decision making and management**				
F1	Adopt CLUM as the WaterNSW land use dataset, consistent with other agencies.	2020	WaterNSW	DPIE	CLUM is freely provided to all NSW agencies by DPIE. The CLUM product is mapped to a very high accuracy and precision and will coincide with the ABS census five-year cycle. It is underpinned by national technical standards (e.g. ALUM classification system) and the mapping technique can be readily replicated. Moving to CLUM data from the previous WaterNSW method will provide a baseline dataset able to be monitored and evaluated over time. In future

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					audits, it will be possible to use CLUM to assess land use changes across the Catchment. (Vol. 2 s.4.4)
F2	Update the catchment-wide analysis and mapping of gully erosion, including some on-ground validation of data.	2020	LLS	WaterNSW	Updated data is needed to inform management of gully erosion across the Catchment (Vol. 2 s.6).
F3	Expand the groundwater monitoring program and review data collection methods consistent with the NSW Water Monitoring Framework (WMF).	2020	DPIE - Water	WaterNSW	The NSW Government has previously recognised the need to expand its groundwater monitoring network to improve understanding of this important natural asset (Vol. 2 s.12.6).
F4	Consolidate fire data from multiple agencies and make this more widely available via SEED.	2020	RFS	DPIE	The NSW Government has established the Sharing and Enabling Environmental Data (SEED) platform to improve data access and decision-making. Use of SEED would reduce the likelihood of fire data being unavailable when resources are fully engaged in operational matters (Vol. 2 s.13.2).
F5	Post annual updates on implementation progress for audit recommendations that include all public authorities, not just the recommendations to be implemented by WaterNSW.	Ongoing	WaterNSW	All agencies	The community requested that audit implementation progress reports be more easily accessible (Vol. 2 s.2.3 and Vol. 3 Appendix B).

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