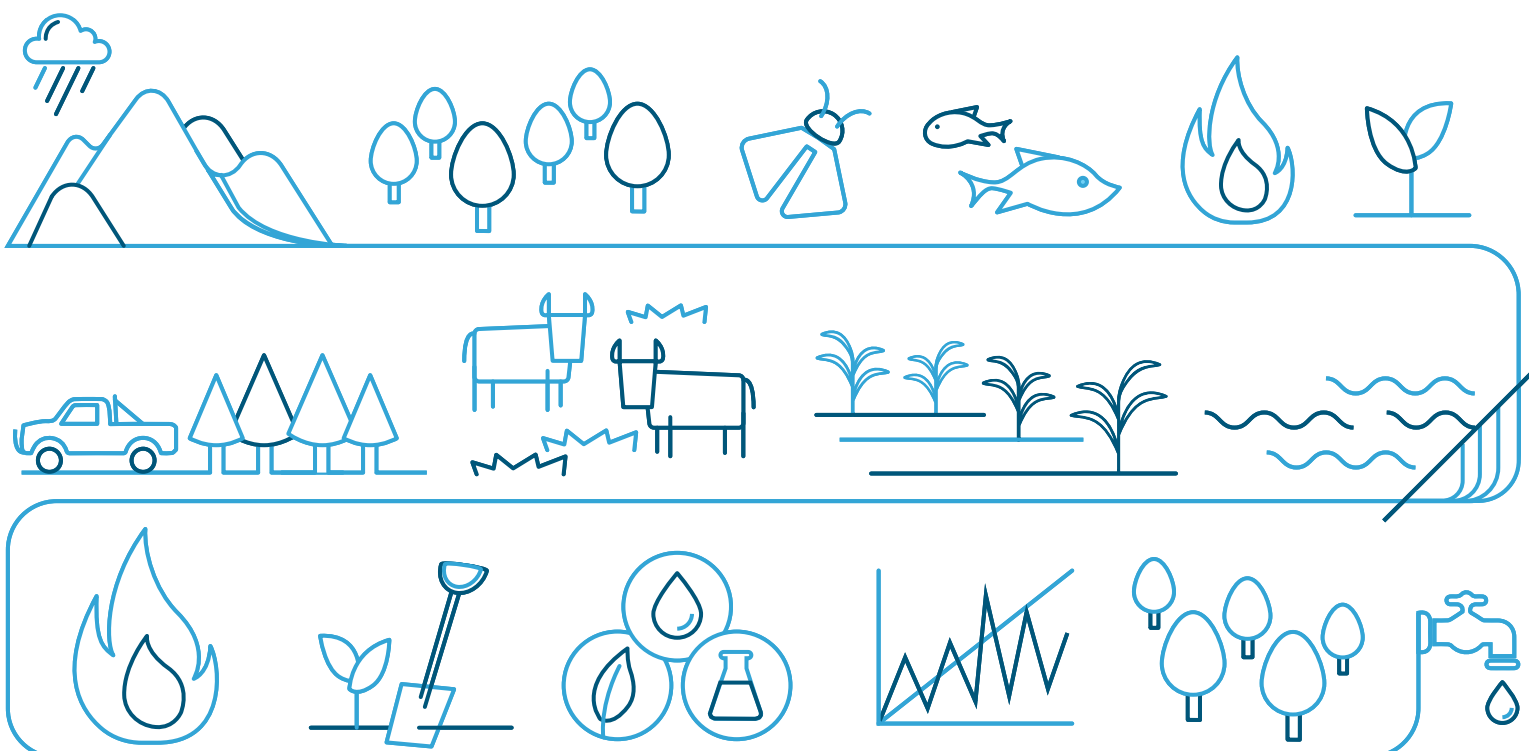




COMMISSIONER FOR SUSTAINABILITY
AND THE ENVIRONMENT

THE HEROIC AND THE DAMMED – LOWER COTTER CATCHMENT RESTORATION EVALUATION

December 2018



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CONTENTS

Foreword	6	2.6 Icon Water, ACT's Only Water Utility	25
1. Preamble	10	2.7 Water Regulators and the Licence to Take Water	25
1.1 Ashes to Ashes	11	2.8 Legislation, Statutory Requirements, and Management as a Reserve	26
1.2 Background to this Report	12	3. The Story of the Lower Cotter Catchment	28
1.3 Approach to this Report	12	3.1 Overview: A Complex Ecosystem, Challenging to Manage	29
1.4 Report Structure	13	3.2 Geography and Geology	30
2. Introduction and Context	14	3.2.1 Map of the Lower Cotter Catchment	30
2.1 Context: The Auditor-General's Report No. 3/2015	15	3.2.2 Geography	32
2.2 The Standing Committee on Public Accounts Review of the Auditor-General's Report No. 3/2015	15	3.2.3 Geology	32
2.3 Lower Cotter Catchment Reserve Management Plan 2018	15	3.2.4 Sub-catchments within the Lower Cotter Catchment	32
2.4 Key Stakeholders for the Lower Cotter Catchment	18	3.3 Water Context in the Lower Cotter Catchment	34
Expert Commentary: Collaborative Management and Governance in the Lower Cotter Catchment	20	3.3.1 History of the Cotter Dam	34
Case Study: Think Before You Drink	22	3.3.2 Long-term Water Security for the ACT	35
2.5 ACT Government Water Policy and Planning	24	3.3.3 Source Water Protection	35
2.5.1 ACT Water Strategy 2014–44: Striking the Balance	24	3.3.4 Investment in Natural Water Filtering Services	36
2.5.2 ACT Government Integrated Water Monitoring Plan	25	3.4 Land Use in the Lower Cotter Catchment	36
		3.4.1 History of Fire	36
		Expert Commentary: Issues in Respect of Fire Risk Management in the Lower Cotter Catchment	38

3.4.2 Agriculture	39	Case Study: Tracking the Water Abstraction Charge (WAC)	74
3.4.3 Commercial Forestry	40	4.3.3 Implementation Status of PAC Report Recommendations	76
3.4.4 Building Resilience: Water Catchment Management and Native Revegetation	42	4.4 Professor Ian Falconer's Comparative Assessment of Ecological Restoration 2015–2018	79
Expert Commentary: Lessons in System Resilience and Adaptation from the Lower Cotter Catchment	44	4.4.1 Overview	79
Case Study: Importing Engineers: Bettongs Belong	46	4.4.2 Assessment Criteria	79
3.5 Cotter and the Canberra Community	47	Case Study: Blackberry – The Thicket and the Thin	80
4. Evaluation of Ecological Restoration 2015–18	48	4.4.3 Comparative Assessment – Summary Findings	82
4.1 Ecological Restoration Evaluation: Purpose and Approach	49	4.5 Evaluation of Ecological Restoration Conclusions	84
4.2 Review of the Implementation Status of Auditor-General's Report Recommendations	51	5. Monitoring and Evaluation Framework for the Lower Cotter Catchment	86
4.2.1 Overview	51	5.1 Monitoring: A General Commentary	87
4.2.2 Implementation Status of Auditor-General's Report Recommendations – Summary Findings	52	5.1.1 Effective Monitoring and Adaptive Management	87
4.2.3 Implementation Status of Auditor-General's Report Recommendations	53	5.1.2 Monitoring to Manage Risk	88
Case Study: Erosion and Sediment Budgets	68	5.1.3 Challenges to Effective Ecological Monitoring	89
Expert Commentary: Effective Management of Broad Scale Erosion Remediation Works	70	5.1.4 Evaluation	89
4.3 Standing Committee on Public Accounts Review of Auditor-General's Report Recommendations	72	5.2 Existing Monitoring in the Lower Cotter Catchment	90
4.3.1 Overview	72	5.2.1 Overview	90
4.3.2 Implementation Status of PAC Report Recommendations – Summary Findings	73	5.2.2 Icon Water	90
		Case Study: Icon Water's Fish Management Plan	91
		5.2.3 Icon's Licence to Take Water and Environmental Flows	91
		5.2.4 Aboriginal Water Assessments and Cultural Flows	91

Expert Commentary: A New Paradigm in Water Management and Planning for the ACT – The Inclusion of Cultural Indicators for Ngunnawal Country	92	5.6.4 Map of Lower Cotter Catchment Monitoring Sites	107	
Case Study: Valuing Water in a New Western Tradition – Environmental Economic Accounting	94	5.6.5 Evaluating the Lower Cotter Catchment Monitoring and Evaluation Framework	108	
5.2.5 Monitoring by Parks and Conservation Service	94	5.7 Implementation of the Framework	109	
5.2.6 Conservation Effectiveness Monitoring Program (CEMP)	95	5.7.1 Leveraging Synergies Through Icon’s Licence to Take Water	109	2
5.2.7 Research and Education	96	5.7.2 Recommendations for Implementation	109	3
5.3 Water Specific Monitoring: National Water Quality Management Strategy	97	6. Imminent Risks and Interventions	110	
5.4 Australian Drinking Water Guidelines	97	6.1 Imminent and Emerging Risks	111	
5.5 Lower Cotter Catchment Monitoring and Evaluation Framework	97	6.1.1 Climate Change	111	
5.5.1 Development of the Lower Cotter Catchment Monitoring and Evaluation Framework	97	Case Study: ACT Water Security Modelling	114	
5.5.2 The Benefit of a Risk Based Approach	97	Expert Commentary: Water and Climate Change in the ACT	115	
5.5.3 Scope for the Monitoring and Evaluation Framework	99	6.1.2 Population Growth and Health Risks	117	
5.5.4 Conducting A Desktop Analysis	99	6.1.3 Biosecurity – Pests, Pathogens and Pollution	118	
5.5.5 Answering Key Questions to Inform the Monitoring and Evaluation Framework	99	Case Study: Burnouts in the Bush	120	
5.6 Lower Cotter Catchment Monitoring and Evaluation Framework	100	6.1.4 Pest Plant and Animal Species	122	
5.6.1 The Framework: Theory	100	6.1.5 Vulnerable Alpine Ecosystems	123	
5.6.2 Staged Approach (Baseline, Risk and Activity-based, Long-term)	101	Case Study: Brumbies and Deer Loom Near	124	
5.6.3 Monitoring Program	102	6.2 Interventions	126	
		6.2.1 Building Ecosystem Resilience	126	
		6.2.2 Emerging Technologies	126	
		6.2.3 Modelling and Mapping	127	

7. Conclusions and Recommendations	128	Appendices	136
7.1 Report Conclusions	129	Appendix 1 – Legislation	137
7.2 Recommendations	130	Appendix 2 – Complete Reference List	140
Recommendation 1: Monitoring and Evaluation Implementation	130	Appendix 3 – Water Quality Monitoring and Evaluation Schedule for Lower Cotter Catchment	144
Recommendation 2: Funding and Resources Commitment	131		
Recommendation 3: Governance Improvements	132		
Recommendation 4: Coordination of Efforts	133		
Recommendation 5: Legislative Interventions	134		

Acknowledgement of Country

As we open this report on the Lower Cotter Catchment restoration work we start by recognising and acknowledging the Traditional Custodians of the lands on which this report is based. We acknowledge the Ngunnawal people and neighbouring Nations, including the Ngambri, Ngarigo, Wolgalu, Gundungurra, Yuin, and Wiradjuri.

The cultural iconography of these First Nations people is found across the landscape of present day Canberra and within the boundaries of the Australian Capital Territory. For non-Aboriginal people, the work of Josephine Flood provided an early alert about the number and significance of some of the places of spirit and sustenance.¹ Aboriginal people need no such guidance. For thousands of years these Nations have maintained a tangible and intangible cultural, social, environmental, spiritual and economic connection across these lands and in these waters.

In making this acknowledgement we recognise the individuals and their continuing and contemporary cultural connectivity. We also acknowledge the continued displacement from Country following European settlement.

The practice of acknowledging Traditional Custodians and of seeking permission to enter or use natural and cultural resources has always been part of Ngunnawal societies. This practice is now an embedded convention in contemporary Australian society. Recently, and most notably, recognition is being advanced in treaty making processes (Victoria is a leading example of this), and as a function of the work done by Aboriginal people across the country to develop the Uluru Statement from the Heart (now subject to a Senate Joint Committee on Constitutional Recognition).²

Reconciliation and recognition of Aboriginal people and their land and water management practices are critical to the manner in which we build sustainable environmental outcomes – practically and symbolically. For this reason, this office supported the establishment of the ACT's Reconciliation Day, first celebrated in 2018.

This report addresses some of the issues which confront Aboriginal people in the ACT in respect of environmental land and water management practices; promotes the building of partnerships which generate understanding and meaningful dialogue with government and research institutions; and, seeks to find a balance between traditional practices and contemporary science.

For the purpose of this report, it is fundamental for the narrative, recommendations, and future success of the Lower Cotter Catchment restoration work, that Traditional Custodians be provided with the appropriate access and means to contribute to catchment planning, management and evaluation. As Kamilaroi scholar, and expert commentator in this report, Bradley Moggridge, has observed,

“The Aboriginal voice needs to be heard at all levels, and mechanisms need to be developed to empower that voice. The community’s fight is ongoing for their right to water and for the protection of its spirit.”³

This report has been developed in consultation with Ngunnawal people and engagement of cultural processes from the outset. Sections of this report reproduce and appropriately cite Aboriginal and Torres Strait Islander peoples’ intellectual property.

While the purpose of this acknowledgement is a respectful recognition, it should not be considered a substitute for substantive and concrete contributions from Traditional Custodians.⁴ However, it does provide the opportunity for readers to consider the overdue and often overlooked need for Aboriginal contributions to sustainable land and water management, resource use and planning, and Australian identity. Such considerations could have enormous symbolic importance and the ability to be a nation-building exercise in terms of achieving sustainable environmental outcomes.⁵

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Scar tree in Wanniasa public park. Source: Kate Auty⁶

- 1 Flood, J. 1996/2010. *Moth Hunters of the Australian Capital Territory. Aboriginal Traditional Life in the Canberra Region*, Gecko Books, South Australia, and also see 1980, *The moth hunters – Aboriginal prehistory of the Australian Alps*, AIAS, Canberra
- 2 https://www.aph.gov.au/Parliamentary_Business/Committees/House_of_representatives_Committees?url=laca/constitutionalreform/chapter5.htm accessed 24 May 2018
- 3 Moggridge, B. 2018. Where is the Aboriginal Water Voice through the Current Murray-Darling Crisis? *Irrigation Australia* 34(02) pp. 34-35; http://www.awa.asn.au/AWA_MBRR/Publications/Latest_News/Call_to_prioritise_Aboriginal_water_rights.aspx accessed 15 August 2018
- 4 Davis, M. & Lemezina, Z. 2010. Indigenous Australians and the Preamble. *UNSW Law Journal* Volume 33(2) pp. 239-266
- 5 https://www.aph.gov.au/Parliamentary_Business/Committees/Joint/Constitutional_Recognition_2018/ConstRecognition/Final_Report accessed 24 May 2018
- 6 Thanks to Jon Rhodes for his 2018 book *Cage of Ghosts*, Darkwood, which provides the map to guide the uninitiated Non-Aboriginal person to the scar trees at Wanniasa in Canberra.

Foreword





PROFESSOR KATE AUTY, COMMISSIONER FOR SUSTAINABILITY AND THE ENVIRONMENT, ACT

This report is titled 'The Heroic and the Dammed: Lower Cotter Catchment Restoration Evaluation.'

The title reflects the facts.

To attempt to remedy the issues which became pronounced after the 2003 bushfires, the Lower Cotter Catchment requires an heroic, strategic, and coordinated effort by operational and administrative personnel, for several decades to come.

Compounding the many catchment management challenges, I present this report in the shadow of the **Intergovernmental Panel on Climate Change 2018 1.5 Degree Report**,¹ which outlines the confronting circumstances in which we find ourselves in respect of climate change. Water supply issues, extreme precipitation, and drought will continue to concern governments and communities. With drying conditions comes an increased bushfire risk.

Dr Sophie Lewis of the University of New South Wales (and formerly of the ANU) has been tracking Canberra's record-breaking weather and advises that since 2006, Canberrans have been exposed to 15 days over 30 degrees in October, which compares adversely with the previous 62 years (from 1938–2000), when only twelve days over 30 degrees were recorded. Our hot and drying climate is reflected in current water storage levels, decreasing by 12 per cent from 2017 to 2018.

These issues are noted in the body of this report in Chapter 7, where we canvas imminent and emerging risks likely to affect catchment management.

This report has itself responded to a range of changing parameters.

It was not optimal to report within the timeframe set by the Auditor-General, or to respond to the specifics of recommendation 12 of the Auditor-General's Report No. 3/15, as the Terms of Reference changed with the development of an updated statutory management plan for the Lower Cotter Catchment.

These particularities have been managed, and the intent of recommendation 12, outlining the need for this office to evaluate restoration against management goals contained in the statutory management plan, has been addressed.

While this report responds to the Terms of Reference it has been necessary to expand on those Terms to tell the full story of recent restoration efforts.

This has taken us into a review of the implementation status of contemporaneous Auditor-General's recommendations, the Legislative Assembly Standing Committee on Public Accounts Report in response to these, as well as the operational efforts of the land managers and others. No report about the Lower Cotter Catchment would be complete without reference to the full gamut of scrutiny to which restoration efforts have been exposed.

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¹ <http://www.ipcc.ch/report/sr15/> accessed 20 October 2018

Our work considers the implications of a wide range of restoration programs on water provisioning and ecological values, and has been informed by:

- fieldwork with Indigenous and non-Indigenous expert commentators,
- forums, fieldwork, and individual consultations with key stakeholders as well the establishment of a multidisciplinary expert reference group specifically for the purposes of this report,
- consultations with engaged community members and groups, and
- an extensive literature review.

The writing of this report and the consideration of appropriate recommendations has been informed by discussions with regulators, scholars from a range of disciplines, and extensive consultation with operational staff, managers, and others involved in the administration of the Lower Cotter Catchment.

The organisational terrain is complex, and this is explored in the body of this report.

As this report has come together it has become increasingly apparent, notwithstanding the efforts which are being made by all those involved in management and planning, that implementation of a targeted monitoring and evaluation framework for the Lower Cotter Catchment, predicated on a risk based approach, would be the best way of ensuring that all the hard (and heroic) work which has already been undertaken can be appropriately organised and embedded. Development of such a framework has formed part of this evaluation, and has been the subject of examination and analysis by experts and relevant staff.

It has also been apparent that there is a need for adequate recurrent funding, additional to the current level, to facilitate the continued management of the Lower Cotter Catchment in an effective manner, as maintenance is only one of the challenges.

The Lower Cotter Catchment provides drinking water to the people of Canberra and is vulnerable to erosion, pests, and of great concern, fire. This is particularly so under climate change scenarios. These factors alone, without consideration of biodiversity and other values, have persuaded experts that secure and settled funding must be provided to continue the restoration work undertaken to date. Rationally, I have concluded that this funding could be made available from the Water Abstraction Charge, which is collected for the purpose of fulfilling water planning needs.

Finally, I make the observation that whilst this is in many respects a technical report, and will have an audience interested in the research which has informed it, it is my intention that every report produced in my office should be accessible to a range of readers. For this reason we present material in this report which may be well known to those who work on the ground or have had extended dealings in the catchment over time.

I have asked my staff to compile this report for the public. To that end, it contains a brief history of the catchment and uses case studies to engage readers and tell the story of the Cotter River and the broader catchment. Further, expert commentaries have been commissioned to demonstrate the extent of the interest in the restoration of the catchment. Amongst these commentaries are the observations from Kamilaroi Indigenous water scholar, Bradley Moggridge.

This report cannot predict what, in the short term, the forthcoming summer season holds for Canberra residents and their water supply. Bushfire risk, clear from the legacy of the 2003 fire and brought to the surface most recently by the Pierces Creek fire, is ongoing and significant.

Fire in the Lower Cotter Catchment has impacted people, flora, fauna, the landscape, soils, water quality, and the catchment more broadly. We can expect similar seasons. We can actively and strategically plan for less confronting outcomes.

This report is part of that process, and cannot be seen as unconnected to these realities.

I hope this report and its recommendations serve to inform not only the government, policy officers and operational and other managers, but also a wider public.

I commend this report to the Minister.

1.

Preamble



1.1 Ashes to Ashes

The Cotter River and the landscape of the Lower Cotter Catchment contribute to a network of Aboriginal pathways in and around what we now refer to as the Australian Capital Territory (ACT).

To the south of the ACT, the continuity and critical importance of such pathways to Aboriginal people is evocatively illustrated in the recent tracing by Aboriginal and non-Aboriginal people of the Bundian Way, an Aboriginal road which traversed the ranges and valleys of the Australian Alps in Kosciuszko National Park to TwoFold Bay on the South Coast of New South Wales (NSW).¹

Indigenous pathways have been a vital element in the Aboriginal landscape, providing access to resources and acting as trade routes. Formal ceremonial and religious occasions, and social interactions were nurtured by these routes. Beyond the functional, these pathways continue intrinsic Aboriginal cultural experience, not only as physical ways of moving between places, but in providing ways of translating and transferring knowledge about flora, fauna, food, ritual, environmental risks, values and utility, and all the interconnections of these disparate but linked elements of Country. Cultural connectivity and identity can be found in the cultural iconography associated with these routes.²

Illuminating the depth of Aboriginal people's knowledge of Country is the relationship between water and fire that has been well understood for many thousands of years and continues today.

Contemporary interest and knowledge of cultural burning was evident at the South-east Australia Aboriginal Fire Forum hosted by the Environment, Planning and Sustainable Development Directorate (EPSDD) in May 2018.

While presenting at the forum, Den Barber, Founding Director, Koori Country Firesticks Aboriginal Corporation made this very poignant observation,

“There is only one fire, and that is the right fire for Country.”³

When managed and understood, fire can bring with it life and new beginnings. When taken for granted, fire can be devastating.

Fire will play a role in Canberra's future, whether it is through cultural burning practices, controlled burns or uncontrolled bushfires. The question that remains is whether enough is being done to build resilience in the landscape and water supply to protect the community from the next big fire event.



Pierces Creek bushfire burning out of control, November 2018. Source: Parks and Conservation Service.

- 1 Blay, J. & Eden Local Aboriginal Land Council 2011. Report on a Survey of The Bundian Way 2010-2011 http://www.bundianway.com.au/Bundian_Survey_Public.pdf accessed on 24 September 2018
- 2 Kabaila, P. 2005. High Country Footprints: Aboriginal pathways and movements in the high country of south eastern Australia. Recognising the ancient paths beside modern highways. Pirion Publishing, Canberra
- 3 Den Barber, Founding Director at Koori Country Firesticks Aboriginal Corporation spoken at the EPSDD Cultural Burning Forum, May 2018

1.2 Background to this Report

On 18 January 2003 a series of uncontrolled bushfires that had been burning wild for ten days in NSW and Victoria swept through the ACT, scarring a significant amount of the landscape. Residential areas, drinking water catchments and national parks were all impacted.

The Lower Cotter Catchment, north of Namadgi National Park and east of the Brindabellas was left almost completely denuded.

The landscape, then a mixture of predominately commercial pine plantations with scattered areas of pastoral lands and native vegetation, was reduced to a barren expanse of bare soil, ash, and debris. Water quality and ecological values were seriously compromised.

The fragility of this landscape and the importance of the Cotter Reservoir to water supply in the ACT and surrounding region resulted in immediate action to begin the recovery.

In the 15 years since, the Lower Cotter Catchment has been administered by a number of coordination and decision making groups, plans of management, and various assessments of ecological restoration, all with the primary focus of protecting existing and future domestic water supply.

Evaluating the effectiveness of these restoration works against management objectives is the subject of this Minister-directed report, based on recommendation 12 of the Auditor-General's Report Restoration of the Lower Cotter Catchment Report No. 3/2015.⁴

1.3 Approach to this Report

AUDITOR-GENERAL'S REPORT RECOMMENDATION 12:

The Commissioner for Sustainability and the Environment should evaluate the restoration of the Lower Cotter Catchment against the Management Goals contained in the Strategic Management Plan, and report to the Minister for the Environment on priorities to be identified for the next decade, by December 2017.

(This aligns with the requirement in the Strategic Management Plan for the Plan to be evaluated, Section 1.1)

Recommendation 12 of the Auditor-General's Report No. 3/15 recommended that the Commissioner for Sustainability and the Environment evaluate restoration against ongoing management goals and report on priorities for the next decade.

In response to recommendation 12, in September 2016 Minister Corbell wrote to the ACT Commissioner directing the preparation of a special report under section 12 and 21 of the *Commissioner for Sustainability and the Environment Act 1993*.⁵

At this time, the forthcoming statutory reserve management plan for the Lower Cotter Catchment, superseding the former Strategic Management Plan 2007, was under development.

It was not optimal to report within the timeframe set by the Auditor-General, or to respond to the specifics of recommendation 12 of the Auditor-General's Report No. 3/15, as the Terms of Reference changed with the development of an updated statutory management plan for the Lower Cotter Catchment.

⁴ ACT Auditor-General's Report, Restoration of the Lower Cotter Catchment Report No. 3/2015

⁵ *Commissioner for Sustainability and the Environment Act 1993*

The Commissioner wrote to Minister Corbell to update the Terms of Reference relating to recommendation 12 and allow adequate time following the completion of the plan to conduct an effective evaluation. The Minister acknowledged these changes and granted an extension to December 2018.

During the community consultation period for the Draft Reserve Management Plan 2017, the Commissioner provided a submission that made eight recommendations.

These recommendations related to:

- monitoring,
- evaluation, and
- the need to demonstrate accountability in relation to implementation of action items.

The final Lower Cotter Catchment Reserve Management Plan 2018 was tabled in February 2018.

As there is currently no consistent framework with which to monitor and evaluate restoration and management actions across a spectrum of indicators, a comparative assessment has been conducted for the period 2015–18 using similar criteria and geographic sites identified in the Auditor-General’s Report.

This report provides an update on the implementation status of all twelve recommendations from the Auditor-General’s Report, the seven recommendations from the subsequent Standing Committee on Public Accounts Report, and a broad evaluation of restoration against the key management objectives:

- to protect existing and future domestic water supply,
- to conserve the natural environment, and
- to provide for public use of the areas for education, research and low impact recreation.

Additionally, to support future evaluations and statutory reporting against management objectives and actions, this report provides a framework to monitor and evaluate water quality and ecological values over time and under changing environmental and economic conditions.

1.4 Report Structure

This report includes the following chapters:

Chapter 1 – Preamble

Chapter 2 – Introduction

- background and previous reports,
- key stakeholders, and
- policy context.

Chapter 3 – History

- geography and geology,
- land use history, and
- management as a water catchment.

Chapter 4 – Evaluation

- Auditor-General’s Recommendations,
- Standing Committee on Public Accounts Recommendations, and
- comparative assessment of restoration 2015–2018.

Chapter 5 – Monitoring Framework

- existing monitoring and gaps,
- Lower Cotter Catchment Monitoring and Evaluation Framework, and
- recommendations for implementation.

Chapter 6 – Imminent Risks

- climate change and population growth impacts,
- pest plants and animals, and
- interventions.

Chapter 7 – Recommendations

1. Monitoring and Evaluation Implementation
2. Funding and Resources Commitment
3. Governance Improvements
4. Coordination of Efforts
5. Legislative Interventions

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2.

Introduction and Context



2.1 Context: The Auditor-General's Report No. 3/2015

In 2015, the ACT Auditor-General undertook a review of the effectiveness of management strategies employed by the ACT Government and Icon Water in the management of the Lower Cotter Catchment.

The Auditor-General examined the implementation of the Lower Cotter Catchment Strategic Management Plan 2007,¹ the primary document guiding restoration and land management actions for the period 2007–17.

The Auditor-General's Report, Restoration of the Lower Cotter Catchment Report No. 3/2015,² included twelve recommendations, three of which were considered high priority. All recommendations were accepted by the ACT Government.

These recommendations focused on the need to improve public land management of this important water catchment.

2.2 The Standing Committee on Public Accounts Review of the Auditor-General's Report No. 3/2015

In July 2016, the Legislative Assembly Standing Committee on Public Accounts published Report 31, Review of Auditor-General's Report No. 3/2015.³

The Standing Committee determined that the Auditor-General's Report provided key findings to support all twelve recommendations.⁴ All recommendations were upheld by the Standing Committee, including the three high priority recommendations.

Similarly to the Auditor-General's Report, the Standing Committee recommended that the need for a sustainable funding model for catchment management was of equal importance to achieving short-term outcomes relating to the implementation of recommendations.

In addition to the Auditor-General's findings, the Standing Committee emphasised the:

- importance of finalising a 'recreation strategy',
- development of a 'communication and education strategy', and
- need to address all twelve of the Auditor-General's recommendations.

Each of these recommendations is significant to the Lower Cotter Catchment, and will be addressed in more detail in Chapter 4 of this report.

2.3 Lower Cotter Catchment Reserve Management Plan 2018

The Lower Cotter Catchment Reserve Management Plan 2018⁵ has been prepared as required under the provisions of the *Nature Conservation Act 2014*⁶ and the *Planning and Development Act 2007*.⁷

The final Lower Cotter Reserve Management Plan 2018 was tabled in the Legislative Assembly in February 2018.

The Nature Conservation Act describes the process for preparing the reserve management plan, while the Planning and Development Act establishes the planning and development management objectives for the Lower Cotter Reserve.

The reserve management plan identifies the values of the reserve and describes how the objectives will be implemented and promoted.

The plan provides direction and guidance to the land manager, utility operators, volunteers, visitors, neighbours and the general public about how the Lower Cotter Reserve will be managed over the next ten years.

The management objectives defined for a reserve set aside for the protection of water supply are:

1. to protect existing and future domestic water supply,
2. to conserve the natural environment, and
3. to provide for public use of the area for education, research and low-impact recreation.

1 ACT Government, Lower Cotter Strategic Management Plan 2007

2 ACT Auditor-General's Report, Restoration of the Lower Cotter Catchment Report No. 3/2015

3 Legislative Assembly Standing Committee on Public Accounts Published Report 31, Review of Auditor-General's Report No. 3/2015

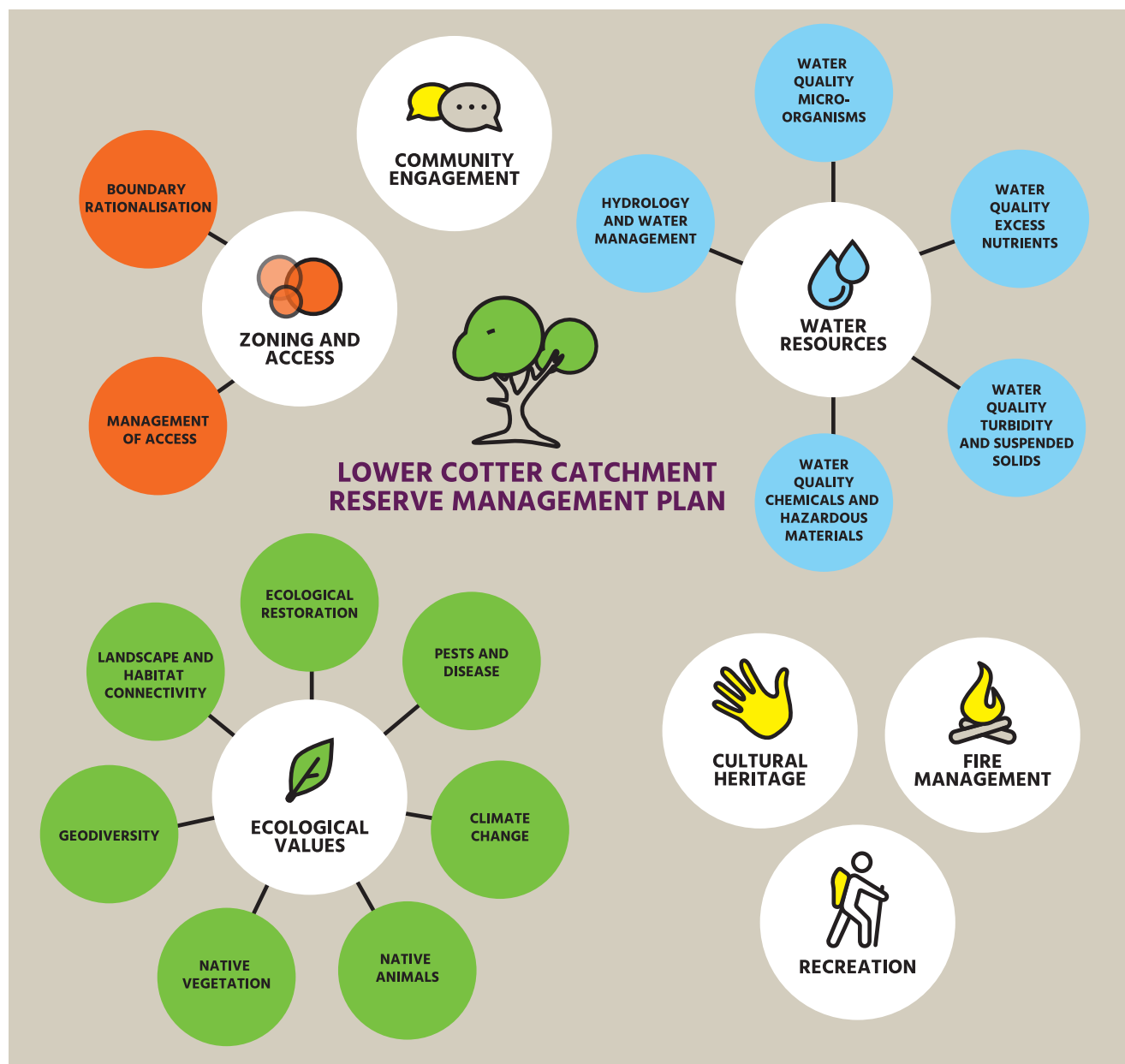
4 <https://www.parliament.act.gov.au/in-committees/previous-assemblies/standing-committees-eighth-assembly/Public-Accounts/review-of-auditor-general-report-no.-3-of-2015-restoration-of-the-lower-cotter-catchment/report?inquiry=796126>, accessed 31 May 2018

5 ACT Government, Lower Cotter Catchment Reserve Management Plan 2018

6 *Nature Conservation Act 2014*

7 *Planning and Development Act 2007*

To support management objectives, the plan contains twelve objectives and 67 actions. These are summarised in the following diagram.

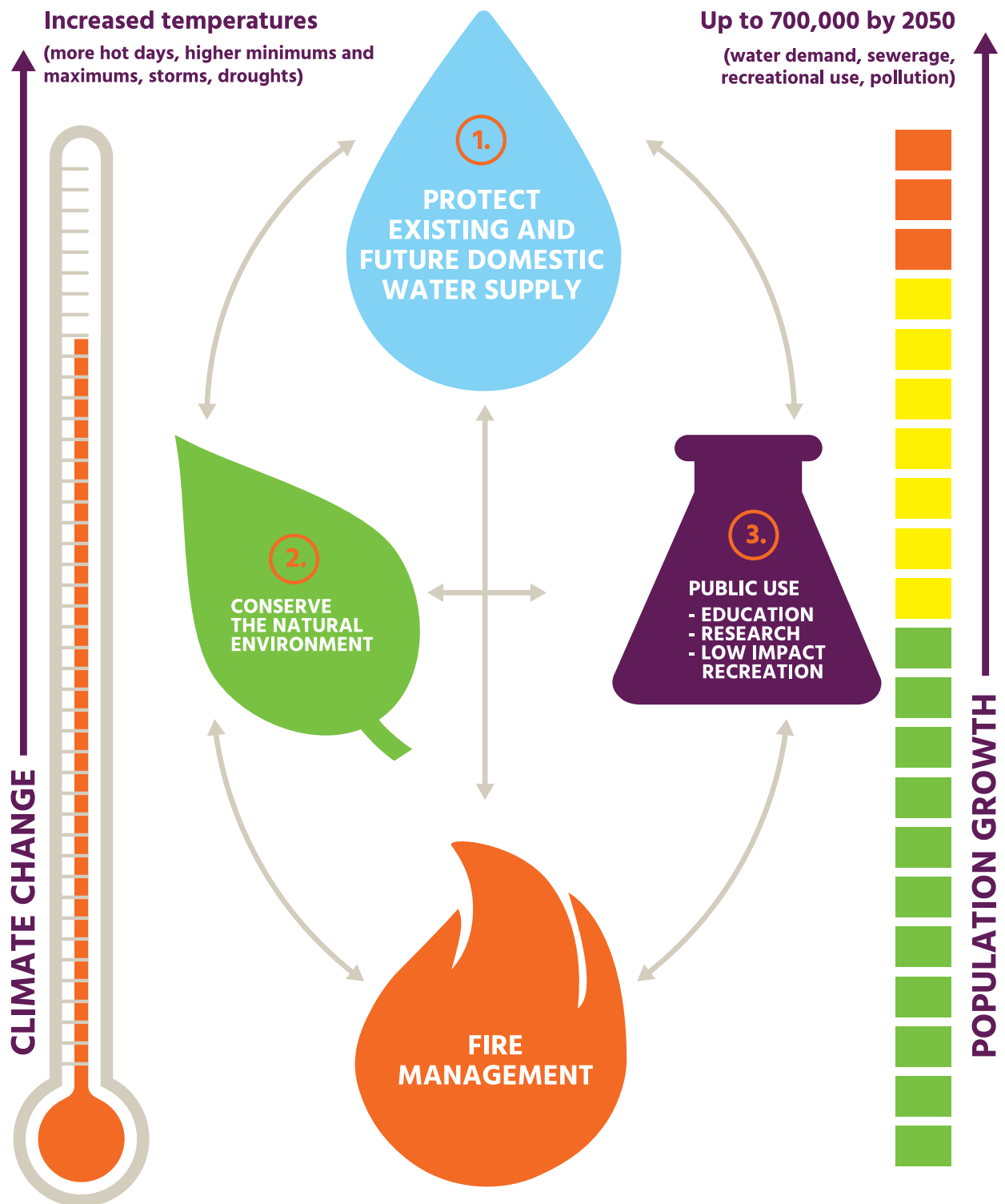


The 67 management actions have been assigned priority ratings and responsible areas, which will form the basis of a separate implementation plan to be developed by the land manager, Parks and Conservation Service.

The implementation plan will include evaluation methods and key indicators to measure the progress and success of implementation. A report on implementation is required to be provided to the Minister five years from the date it is tabled.

As part of this report, a monitoring and evaluation framework has been developed to assess the effectiveness of management actions in line with management priorities outlined in the reserve management plan. The monitoring and evaluation framework is detailed in Chapter 5.

COMPETING MANAGEMENT OBJECTIVES

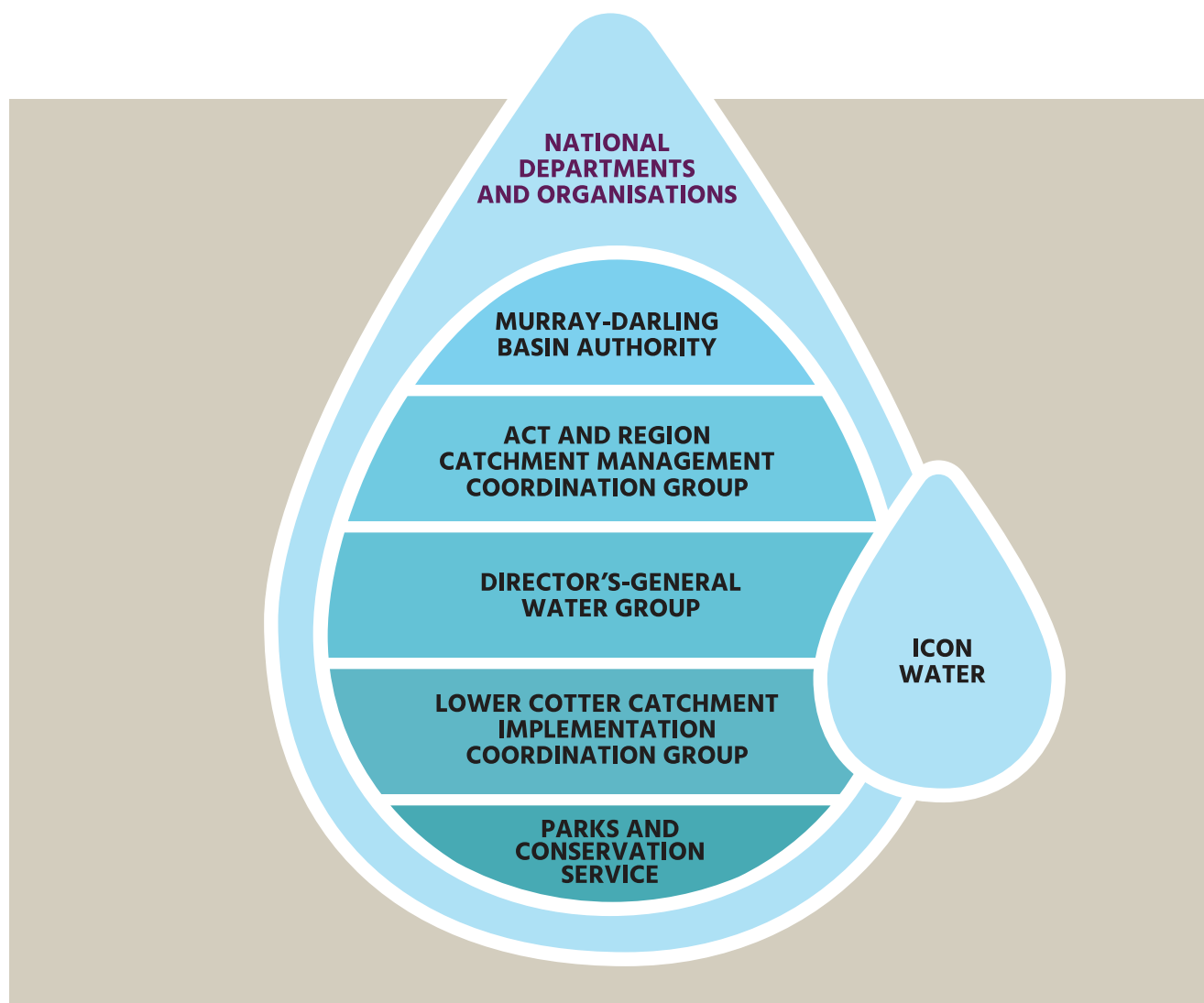


2.4 Key Stakeholders for the Lower Cotter Catchment

KEY STAKEHOLDERS IN THE LOWER COTTER CATCHMENT:

STAKEHOLDER	DETAIL
ACT Parks and Conservation Service (land manager), Environment, Planning and Sustainable Development Directorate (EPSDD)	<p>Parks and Conservation Service is the primary custodian of the land within the Lower Cotter Catchment and responsible for managing the area to meet the statutory objectives. Within Parks and Conservation Service there are two primary business units that manage the Lower Cotter Catchment.</p> <p>Murrumbidgee River Corridor District Office: responsible for erosion control, weed management, pest management, rehabilitation, and visitor access.</p> <p>Fire, Forests and Roads: responsible for all aspects of fire management other than suppression. This includes fire access maintenance, prescribed burning and fire fuel management.</p>
ACT Emergency Services Agency, Rural Fire Service, Justice and Community Safety Directorate	Responsible for emergency response and fire suppression.
Environment Protection Authority, Chief Minister, Treasury and Economic Development Directorate	Regulates the taking of water and the provision of environmental flows from the reservoir under the <i>Water Resources Act 2007</i> .
Icon Water Limited – an unlisted public company owned by the ACT Government with assets and investments in water, sewerage and energy services and operations	<p>Responsible for water supply infrastructure and the use of water stored in the Cotter Reservoir.</p> <p>This includes providing and maintaining water supply and storage infrastructure, dam safety, the water distribution network, reservoir drawdown, treatment for drinking purposes, and monitoring of water quality.</p> <p>Icon Water does not have regulatory powers to control land use in the catchment.</p>
Conservator of Flora and Fauna, EPSDD	<p>Governance oversight between Icon Water and EPSDD.</p> <p>This includes inspection and maintenance works on Controlled Land.</p>
Lower Cotter Catchment Implementation Coordination Group – governance mechanism to coordinate key stakeholders	<p>Key water and land management stakeholders meet regularly to coordinate management activities and decision making.</p> <p>The chair of this meeting reports progress to the Director's-General Water Group.</p>
Director's-General Water Group – governance mechanism to manage water across ACT Government executive	Comprises senior representatives from across ACT Government with responsibilities relating to water and has strategic oversight for high level coordination of Lower Cotter Catchment management.
ACT and Region Catchment Management Coordination Group – governance mechanism for water management across the ACT and region	<p>Cross-jurisdictional coordination group established as a statutory body under the ACT <i>Water Resources Act 2007</i>. The chair of this meeting reports to the ACT Minister for the Environment.</p> <p>Key members include:</p> <ul style="list-style-type: none"> • ACT Government, • NSW Government, • Queanbeyan-Palerang Regional Council, • Snowy Monaro Regional Council, • Yass Valley Council, and • Icon Water.
Murray-Darling Basin Authority – Australian Government	<p>The ACT's water resources form part of the Murray-Darling Basin.</p> <p>The ACT Government manages the amount of water used in the Canberra region under direction from the Murray-Darling Basin Authority.</p>

KEY STAKEHOLDER RELATIONSHIPS FOR THE LOWER COTTER CATCHMENT



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In an effort to address management challenges across a complex and multi-jurisdictional catchment, the ACT and Region Catchment Strategy⁸ aims to improve:

- coordination,
- cooperation, and
- collaboration.

The strategy addresses five key themes:

- governance, policies and planning,
- communities,
- regional development,
- water, and
- land and biodiversity.

Under the 'governance' theme, the strategy establishes a framework for decision making, taking into account

stakeholder values, the evidence base, and the benefits of multi-jurisdictional collaboration for the collective, long-term wellbeing of the broader catchment and its residents.

Despite the ACT Government's commitment to effect the Auditor-General's recommendation 3 regarding management and coordination arrangements, there is still a degree of ambiguity surrounding governance roles and responsibilities for the Lower Cotter Catchment.

This issue will be addressed in more detail in Chapter 4.

8 https://www.environment.act.gov.au/__data/assets/pdf_file/0007/919357/ACT-and-Region-Catchment-Strategy-ACCESS.pdf accessed 24 June 2018

COLLABORATIVE MANAGEMENT AND GOVERNANCE IN THE LOWER COTTER CATCHMENT

Dr Annie Lane, former Executive Director and
ACT Conservator of Flora and Fauna, EPSDD



Management of the Lower Cotter Catchment is complex.

Unlike other reserves in the ACT, the Lower Cotter Catchment has many land uses including forestry, recreation, nature conservation and water supply. As a direct consequence of this, the Lower Cotter Catchment involves multiple stakeholders, each with defined roles and responsibilities related primarily to land use and legislated responsibility.

The major stakeholders involved in management of the Lower Cotter Catchment are the land manager, ACT Parks and Conservation Service (PCS), and the water manager, Icon Water.

Other stakeholders with a significant interest and influence are the Emergency Services Agency, the Environment Protection Authority (EPA), and the Conservator of Flora and Fauna.

The Lower Cotter Catchment also has considerable cultural heritage values. The Traditional Custodians, the Ngunnawal people, have an active interest in management of the Lower Cotter Catchment and have made valuable contributions to developing the management plan.

In addition, individuals and groups such as bush walkers and mountain bikers utilise the Lower Cotter Catchment for its natural values and trail network.

Management of the Lower Cotter Catchment is particularly challenging because it is a landscape in recovery. The devastating 2003 bushfires decimated vegetation cover, resulting in ongoing challenges in respect of erosion and sediment control that continue to affect water quality.

Integrated management and collaborative governance is the key.

Integrated management is particularly important for the Lower Cotter Catchment because it is a fragile and recovering landscape that provides essential ecosystem services. The most important of these services is a sustainable and high quality drinking water supply.

The Auditor-General's 2015 audit report on the restoration of the Lower Cotter Catchment concluded that considerable progress had been made but that a more focused effort was required in some areas, including a high priority action to address coordination of management actions.

To this end, PCS took the lead on refreshing the collaborative and coordinated approach to tackling challenges, to protect the valuable drinking water catchment and to accelerate landscape recovery.

A taskforce was established comprised of the major agencies – PCS (chair), Icon Water, Emergency Services Agency, EPA, and policy and research areas in the then Environment and Planning Directorate.

The taskforce agreed the overarching objectives for managing the Lower Cotter Catchment were to:

1. protect the Lower Cotter Catchment as a high-quality drinking water catchment (primary objective),
2. improve the catchment's environmental values, recognising it is a recovering landscape, and
3. provide recreational opportunities that are compatible with one and two above.



The taskforce instigated a risk management approach to address the challenges impacting catchment health. This systematic approach allowed the prioritisation of risks, and assignment of responsibility to address each risk in a timely and coordinated manner.

Risks were identified based on key functions such as cultural values, native vegetation, pine plantations, fire management, and water quality management.

The resulting document, Lower Cotter Catchment Risk Treatment Plan, provides a basis for monitoring progress and adjusting management approaches as required. Monitoring of the plan includes considering whether:

- the risk assessment remains relevant,
- implementation of the Risk Action Plan is on track, and if not why not,
- identified current controls are being monitored for their effectiveness and adjusted as required, and
- allocated responsibilities are up to date.

Ongoing and active governance is critical where multiple agencies are involved in management.

The Director’s-General Water Group is a cross agency group that meets quarterly to discuss and make

decisions on water-related matters. This group took responsibility for whole of government oversight to manage the Lower Cotter Catchment and to ensure implementation of the Auditor-General’s Report findings in particular.

The taskforce provided regular progress reports to the Director’s-General Water Group, which offered direction and additional support where required. The fact that the Lower Cotter Catchment received such high-level attention reflects its importance to the ACT Government and community.

This controlled and collaborative approach to addressing a complex set of challenges in the Lower Cotter Catchment has accelerated restoration progress and generated considerable goodwill between all involved. The majority of the Auditor-General’s recommendations have been addressed in a timely manner but still require ongoing attention.

The complexity of managing a drinking water catchment in a state of recovery while playing host to an array of other land uses will not diminish.

Integrated management and collaborative governance need to remain as permanent principles to achieve and sustain management objectives for the Lower Cotter Catchment.

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THINK BEFORE YOU DRINK



Citizens of the ACT enjoy some of the highest quality drinking water in the world.

This can be attributed in part to the pristine environment from which source water is derived, in combination with the ACT Public Health (Drinking Water) Code of Practice 2007⁹ and the Australian Drinking Water Guidelines 2011.¹⁰

In the ACT, the water journey starts from alpine and sub-alpine catchment zones, rivers and reservoirs before flowing through filtration plants designed to remove contaminants.

A comprehensive monitoring program verifies water quality throughout the distribution network. Icon Water conducts more than 5,000 routine water samples annually, spanning the entire system from catchment, to service reservoirs, through to customer taps, with the aim of being 100 per cent compliant with the Guidelines.¹¹

Not only is the ACT's tap water of the highest quality, it is also some of the cheapest.

In 2018, the Independent Competition and Regulatory Commission¹² reported that Icon Water's combined bill for residential customers was lower than the national industry average for urban water providers.

This price regulation has allowed for measured and gradual rebalancing of tariffs which will improve affordability while continuing to promote water conservation.

9 ACT Public Health (Drinking Water) Code of Practice 2007

10 Australian Drinking Water Guidelines 2011

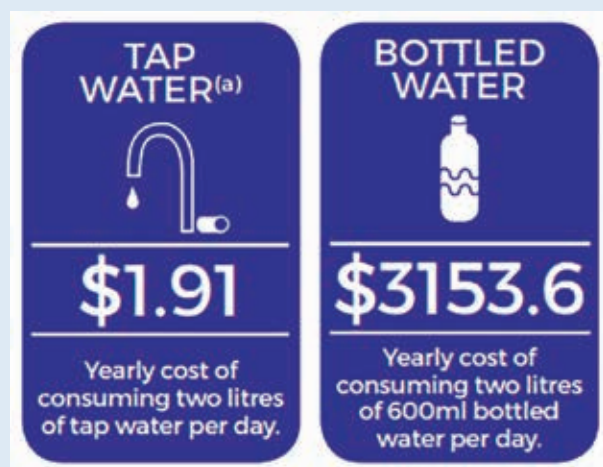
11 <https://www.iconwater.com.au/water-and-sewerage-system/sustainability-and-environment/sustainability-and-environment-programs/protecting-water-supply.aspx> accessed 6 June 2018

12 Independent Competition and Regulation Commission Final report Regulated water and sewerage services prices 2018–23

Considering the quality and price of the ACT's tap water, in addition to the known environmental cost of bottling water in plastic bottles, it is somewhat surprising that we (like others) continue to pay for and use bottled water.

The Australasian Bottled Water Institute¹³ assures the community that all plastic bottles are made from recyclable material. However, sadly less than half are actually recycled, with the remaining 60 per cent going straight to landfill.

Clean Up Australia¹⁴ reports that plastic bottles are among the ten most common rubbish items. To combat this problem they actively encourage people to avoid bottled water and use a reusable bottle.



Source: ACT Chief Health Officer's Report 2018

Beyond the plastic pollution problem, bottled water has to be pumped out of the ground, packaged, transported, and is generally chilled before being consumed. This process creates over 60,000 tonnes of greenhouses gases per year in Australia alone.¹⁵

As to cost, it takes eight years to recoup the actual cost of production of a bottle of water by refilling the bottle with tap water.¹⁶

Some towns and organisations across Australia have taken steps to promote tap water by banning bottled water completely. In 2011, The University of Canberra was the first university in Australia to implement a full-scale ban.¹⁷ Meanwhile, Yarra Valley Water in Victoria is enjoying success with its Choose Tap campaign,¹⁸ the first fully integrated, grass-roots program of its type in the world.

The message is simple: think before you drink and choose tap water – the best hydration choice for the environment, people's health, and hip pocket.

13 <https://www.choice.com.au/food-and-drink/drinks/water/articles/bottled-water> accessed 3 June 2018

14 <https://www.choice.com.au/food-and-drink/drinks/water/articles/bottled-water> accessed 3 June 2018

15 <https://www.coolaustralia.org/bottled-water-secondary/> accessed 3 June 2018

16 <https://www.coolaustralia.org/bottled-water-secondary/> accessed 3 June 2018

17 <http://www.canberra.edu.au/media-centre/2011/january/21-water> accessed 3 June 2018

18 <https://www.yvw.com.au/help-advice/community-programs/choose-tap> accessed 3 June 2018

2.5 ACT Government Water Policy and Planning

2.5.1 ACT WATER STRATEGY 2014–44: STRIKING THE BALANCE

THE STRATEGY

The ACT Water Strategy 2014–44: Striking the Balance¹⁹ adheres to the Murray–Darling Basin Plan,²⁰ which places requirements on the ACT and other jurisdictions in relation to water use and quality.

The Strategy sets out the ACT Government’s vision for water resource management, detailing water-related policies and priorities, including water supply, management and catchment practices over the next 30 years.

Fact Box

MURRAY-DARLING BASIN

The ACT is wholly situated within the Murray-Darling Basin, Australia’s biggest river system.

The Murray-Darling Basin is coping with climate change realities. In 2018, 100 per cent of NSW was declared in drought, as was 70 per cent of Queensland.

The ACT has launched its own Drought Policy, and continues to be an active and responsible participant in managing the precious and finite water resources of the Murray–Darling Basin. These commitments place a strong onus on the ACT to manage water quality and ecosystem health within the Territory’s borders.

The ACT seeks to manage water quality to ensure that water leaving the ACT is of the same quality or better than that entering the ACT.

ACTIONS TO IMPLEMENT THE STRATEGY

Actions include the following:

- improved integrated catchment management in the ACT and region,
- long-term security of water supplies to meet the needs of a growing population and the environment,
- strategic investment in catchment management and water security,

- integrated water cycle management in the planning and design of urban environments,
- provision of safe and clean water for the ACT, and
- promoting and building on strong community involvement in water resource management.

HEALTHY WATERWAYS

ACT Healthy Waterways²¹ is a jointly funded Australian and ACT Government project aimed at improving water quality in the ACT. The ultimate goal is to improve the quality of water returning to the broader Murray-Darling Basin.

Major infrastructure components of the program include:

- the construction of wetlands,
- raingardens, and
- other waterway restoration projects.

Investment is being made in:

- community education,
- behaviour change,
- research, and
- monitoring.

MONITORING

Monitoring of the ACT’s aquatic and riparian ecosystems provides data for the systematic evaluation of the effectiveness of management actions aimed at maintaining and improving ecosystem condition. This level of reporting supports adaptive, evidence-based decision making.

Monitoring is typically carried out by the ACT Government in association with partners, including Icon Water, the University of Canberra and community groups such as Waterwatch, Frogwatch²² and catchment management groups.

A range of other water monitoring requirements across the ACT Government, Icon Water and the Commonwealth Government, which impact on the EPSDD program, include:

- flood mapping, warning and response,
- stormwater network design, stormwater use and managed aquifer recharge,
- dam safety,
- potable water health, safety and water security,
- public irrigation, and
- compliance.

¹⁹ ACT Government 2014. ACT Water Strategy 2014–44: Striking the Balance

²⁰ Australian Government 2012. Murray-Darling Basin Plan

²¹ <https://www.environment.act.gov.au/water/ACT-Healthy-Waterways/home> accessed 14 March 2018

²² <http://sactcg.org.au/node/915> accessed 13 June 2018

2.5.2 ACT GOVERNMENT INTEGRATED WATER MONITORING PLAN

INTEGRATED WATER MONITORING PLAN – MAJOR CHANGES TO DATA MANAGEMENT

A systematic review of water monitoring activities in 2017 culminated in the Integrated Water Monitoring Plan.²³ This plan mapped out existing monitoring programs and made recommendations for new monitoring initiatives.

In addition to this, the review recommended major changes to data management, sharing, and usage in the ACT.

These recommendations included consolidating all major water data into a single database, and incorporating data into catchment models. This will aid in predicting impacts and changes to water quality to support proactive management.

EPSDD is working with the Office of the Chief Digital Officer to deliver a whole of government database as outlined in the ACT Digital Strategy 2016–2019.²⁴

2.6 Icon Water, ACT's Only Water Utility

Icon Water Limited is an unlisted public company owned by the ACT Government and is the only water utility in the Territory.

Operating as a business, Icon Water owns and manages the assets and operations of water and sewerage services to the ACT, and the bulk of water provided to Queanbeyan.

Icon Water has corporate reporting and compliance obligations under Corporations Law, and is regulated by over 70 Acts, Regulations and Codes. This includes the *Utilities Act 2000*, *Water Resources Act 2007*, *Environment Protection Act 1997*, *Water and Sewerage Act 2000* and *Public Health Act 1997*.



Cotter Dam Overflowing. Source: Caitlin Roy

The right to use and control water in the ACT is given to the Territory by the *Water Resources Act 2007* and the right is exercised by the relevant Minister, subject to Murray-Darling Basin Authority direction.

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2.7 Water Regulators and the Licence to Take Water

Icon Water's Licence to Take Water (WU67) is reviewed and updated annually by the Environment Protection Authority, ACT Health and Icon Water, to allow for changes that reflect current issues and operations.

For example, changes have been made in the past to address:

- reduced environmental flow requirements during water restrictions,
- flow regulation during construction such as the new Cotter Dam,
- extending monitoring programs to support new infrastructure such as the inclusion of Murrumbidgee pumping stations, and
- include monitoring for emerging contaminants of concern.

²³ ACT Government 2018, Integrated Water Monitoring Plan

²⁴ ACT Government Digital Strategy 2016-2019

2.8 Legislation, Statutory Requirements, and Management as a Reserve

ACT LEGISLATION

The following list of ACT legislation provides an illustration of the level of regulatory complexity involved in managing the water resource and catchment in the Lower Cotter.

1. *Planning and Development Act 2007* governs land use in the ACT. The Act:
 - establishes the Territory Plan,
 - provides for the identification of Public Land and its reservation for defined purposes,
 - defines management objectives for each category of Public Land, and
 - provides for environmental impact assessment.²⁵
2. *The Nature Conservation Act 2014* is the chief legislation for the protection of native plants and animals in the ACT, including the declaration of threatened species and ecological communities. The Act:
 - prescribes the process for preparing reserve management plans for reserves,
 - includes provisions that apply to managing recreation activities in reserves, and
 - provides for offences and penalties for clearing and damaging land in reserves, and for damaging infrastructure.

The Act also contains Activities Declarations, provided for under Sections 256 – 258, forming a critical part of visitor management in the Lower Cotter Catchment.

An Activities Declaration is made by the Conservator of Flora and Fauna on a reserve-by-reserve basis and informs the public about which recreational activities are prohibited or restricted (permitted in the reserve under certain circumstances). Offences and penalties apply for breaches of Activities Declarations.

3. *The Emergencies Act 2004* establishes requirements for fire management in the ACT, including the preparation of the ACT Strategic Bushfire Management Plan.
4. *The Heritage Act 2004* establishes a system for the recognition, registration and conservation of natural and cultural heritage places and values.
5. *The Human Rights Act 2004* is an Act to respect, protect and promote human rights. The Act acknowledges that Aboriginal and Torres Strait Islander peoples hold distinct cultural rights and must not be denied the right to maintain, protect and develop their culture. The Act recognises their material and economic relationships with the land, water and other resources.

6. ACT Health regulates the supply of drinking water in the ACT and provides licences to operators of drinking water systems under the *Public Health Act 1997*. The Public Health (Drinking Water) Code of Practice 2007 lists the technical requirements for the supply, quality, monitoring and reporting on drinking water by the water utility. The code of practice requires certain events or incidents to be notified to the ACT Chief Health Officer.

Other key Territory legislation related to managing land in the Lower Cotter Catchment is shown in Appendix 2.

FORMALISING THE LOWER COTTER CATCHMENT – THE NATURE CONSERVATION ACT 2014

In 2014 the parcel of Controlled Public Land known as the Lower Cotter Catchment was formalised as a reserve set aside for the protection of a water supply under the *Nature Conservation Act 2014*.

As a result, ACT Parks and Conservation Service is the contemporary custodian of the land within the Lower Cotter Catchment, and is responsible for managing the area to meet the statutory objectives.

Under a reserve management plan, the custodian is subject to the following requirements:

1. The custodian of the reserve must report to the Minister about the implementation of the plan at least once every five years.
2. The custodian of the reserve must review the plan,
 - every ten years after the plan commences, and
 - at any other time at the Minister's request.

COMMONWEALTH LEGISLATION AND REGULATORY ARRANGEMENTS

The main Commonwealth legislation relevant to management of the Lower Cotter Catchment is the *Environment Protection and Biodiversity Conservation Act 1999*. This Act provides for environmental impact assessment of proposals that may impact on matters of national environmental significance, which include Commonwealth-listed threatened species and ecological communities.

The Commonwealth *Water Resources Act 2007* requires the ACT to manage surface water and groundwater consistent with the Murray-Darling Basin Plan. The Act defines access rights to surface and groundwater resources, environmental flow provisions, water licensing requirements, resource management and monitoring responsibilities and sets penalties for improper actions. Protection of environmental flows is the most important principle of the Act. Environmental flows are defined in the Environmental Flow Guidelines, which is a legislative instrument under the ACT Water Resources Act.²⁶

²⁵ ACT Government, Lower Cotter Catchment Reserve Management Plan 2018

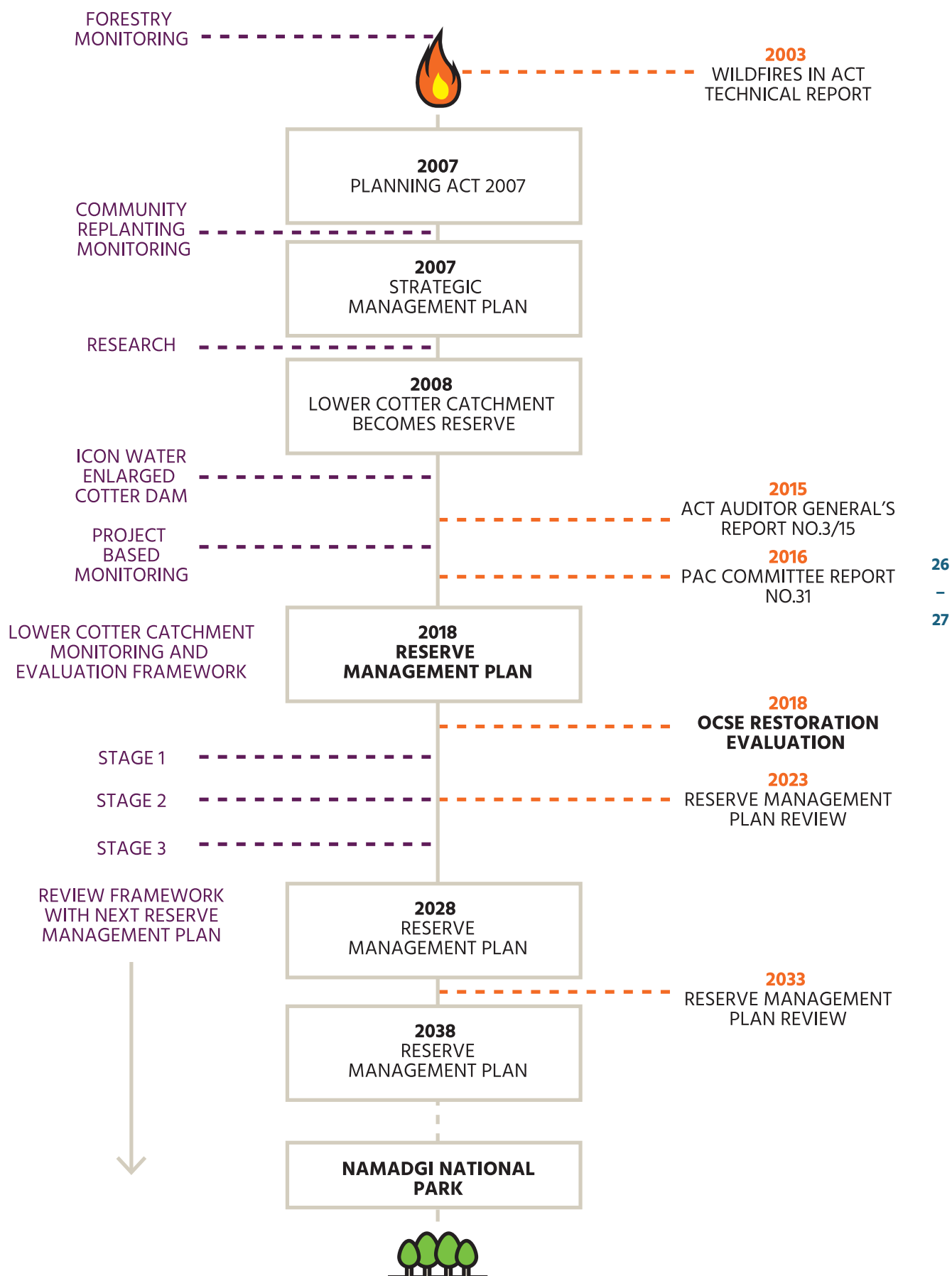
²⁶ https://www.environment.act.gov.au/__data/assets/pdf_file/0019/621424/ACT-Water-Strategy-ACCESS.pdf accessed 24 June 2018

MANAGEMENT TIMELINE

MONITORING

TIMELINE

EVALUATION



3.

The Story of the Lower Cotter Catchment



3.1 Overview: A Complex Ecosystem, Challenging to Manage

The Cotter River has played an important role in the history of the Canberra region, in many ways, and for many people. It has served us all well.

The river was of critical importance to Aboriginal people and it continues to be of cultural significance. Before it was dammed the Cotter River was a food source, and the broader catchment and its narrower valleys provided raw materials.

The Cotter River valley, linked to the Molonglo and the Murrumbidgee Rivers, provided a passageway to summer Bogong Moth feasts in the high mountains of the Brindabellas.¹ Observant visitors can still see Aboriginal people's cultural iconography. For example, grinding grooves are found on river rock faces, as are multiple stone scatters. Other indications of connectivity have been relocated following the expansion of the Cotter Reservoir.

The promise of abundant water from the Cotter River was a key factor in the selection of Canberra as the site for the federal capital.² When the ACT was established in 1913, the western boundary was set along the watershed of the Cotter River.³

The Cotter Dam, constructed in 1915, was Canberra's sole water supply until Corin and Bendora Dams were completed in the 1960s. Since European settlement, the Lower Cotter Catchment has been home to agriculture, commercial forestry, and a range of recreational activities.

Major bushfires in the catchment in 2003 caused significant loss of vegetation, including the almost complete destruction of commercial pine plantations which had dominated the landscape in the Lower Cotter. This natural disaster, along with the Millennium Drought, triggered the ACT Government to invest in the enlargement of the Cotter Dam and prompted changes to land management, and priorities to promote a drinking water catchment resilient to major disturbance.

Following the 2003 bushfires, a consortium of ACT government agencies, Icon Water, Greening Australia and the community, have focussed on widespread replanting of native species to drive the eventual retirement of remaining pine plantations in favour of establishing native revegetation.

The effort to restore native ecosystems has been coupled with a focus on cultural, educational, and recreational opportunities in the catchment, even though this remains secondary to other management values.

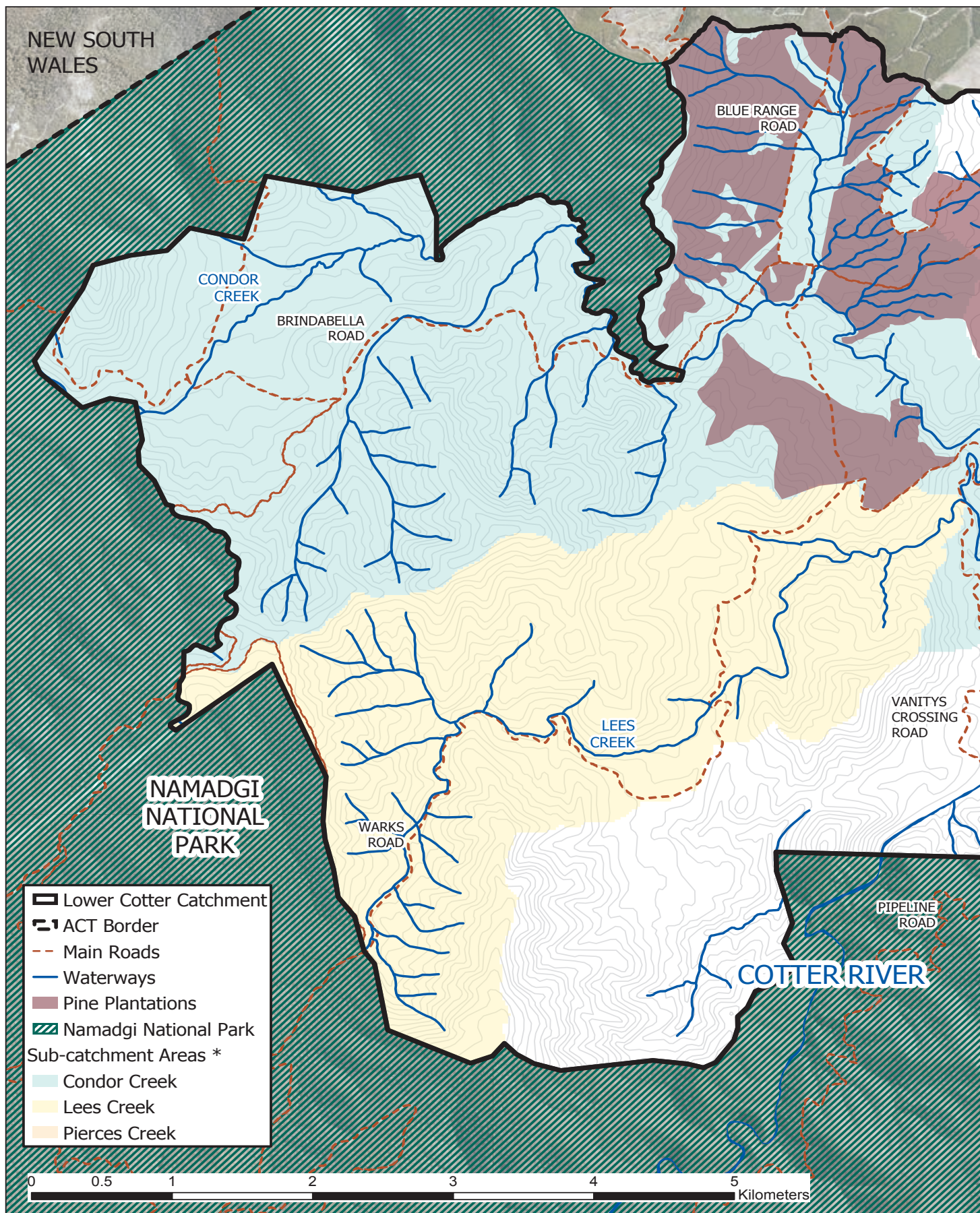
1 https://www.greeningaustralia.org.au/wp-content/uploads/2017/11/CASE-STUDY_Regreening-the-Cotter.pdf

2 Actew AGL Environmental Impact Statement, Enlargement of the Cotter Reservoir, Volume 2, 2009

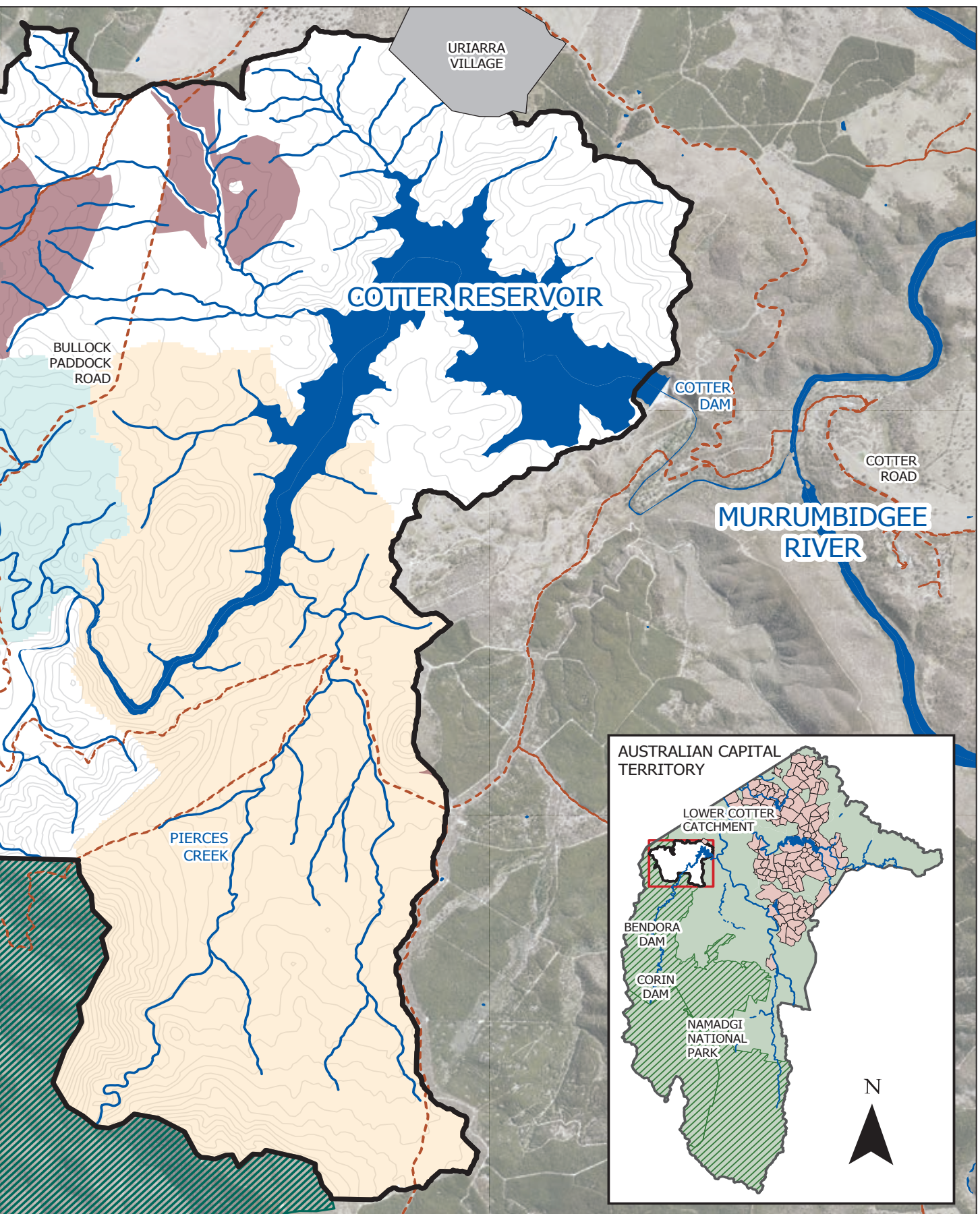
3 ACT Auditor-General's Report, Restoration of the Lower Cotter Catchment, Report No. 3/15

3.2 Geography and Geology

3.2.1 MAP OF THE LOWER COTTER CATCHMENT



* Note: Sub-catchment boundaries may not represent hydrological boundaries with complete accuracy due to the modelling scale



3.2.2 GEOGRAPHY

The Lower Cotter Catchment, as outlined in the reserve management plan, totals 6350 hectares or 63.5 square kilometres. Located in the north-western corner of the ACT, it forms part of the broader Cotter River Catchment within the Murray-Darling Basin.

The Cotter River flows north from the south-west corner of the ACT and is joined by six minor tributaries, including Paddys River, before reaching its confluence with the Murrumbidgee River near Casuarina Sands, west of the Weston Creek residential district.

The river descends 1,300 metres over its 76 kilometre course.

The Cotter River Catchment in its entirety extends over 481 square kilometres and includes three sub-catchments:

- Upper Cotter (Corin Dam Catchment),
- Middle Cotter (Bendora Dam Catchment to Corin Dam), and
- Lower Cotter (Cotter Dam Catchment to Bendora Dam).

All of the upper and middle sub-catchments are protected within Namadgi National Park.

Fed by numerous mountain streams, wetlands and soaks over its 76 kilometre journey, the Cotter is an active montane river for much of the year.⁴

The Cotter Dam is located approximately 18 kilometres west of Canberra's urban zone, with access provided via three main roads.

3.2.3 GEOLOGY

The broader Cotter Catchment is characterised by a centrally incised valley system with steep eastern and western ranges characteristic of Namadgi National Park. Landforms include rolling summits, exposed ridgelines, and rocky outcrops. The Lower Cotter sub-catchment is less steep, with slopes typically less than 10 degrees. However, the Cotter River itself is confined by a steep gorge with slopes greater than 15 degrees.⁵

The Cotter River is a boulder, cobble, and gravel-bed river. The area has underlying geology consisting of marine meta-sediments and volcanic granitoids. Soils derived from granite tend to be highly erodible due to their coarse grain size while soils derived from metasediments have a high percentage of fine grains which can degrade water quality.⁶

Broken down further, each sub-catchment within the Lower Cotter Catchment has different geological, hydrological and geomorphological qualities that impact soil erodibility and affect management activities.



*Cotter River in drought below Cotter Dam Wall, 1929.
Source: National Archives of Australia*

3.2.4 SUB-CATCHMENTS WITHIN THE LOWER COTTER CATCHMENT

COTTER RIVER

The largely intact nature of the upper Cotter River catchment means that water entering into the Lower Cotter Catchment is generally high quality.

The Cotter River is the major tributary feeding the Cotter Reservoir and meets Condor Creek approximately 300 metres from the full supply level of the enlarged Cotter Reservoir.

The main ecological values in the Cotter River relate to native fish fauna, with the Lower Cotter River being home to the nationally threatened Macquarie Perch and the ACT threatened Two-spined Blackfish.

A major threat to both species is sedimentation, which is actively managed in-stream by an environmental flows program from Bendora Dam. Currently sediment accumulation is not monitored or evaluated, which has implications for these fish species.

⁴ ACT Government, Lower Cotter Catchment Strategic Management Plan 2007

⁵ University of Canberra 2018. Lower Cotter Catchment: monitoring and evaluation framework for the protection of water and ecological values

⁶ Actew AGL Environmental Impact Statement, Enlargement of the Cotter Reservoir, Volume 2, 2009

CONDOR CREEK

Condor Creek rises on the eastern slopes of the Brindabella range, to the west of the Cotter River. The headwater catchment is typified by native forest (wet and dry sclerophyll forests) overlying Ordovician metamorphosed sediments covered in erosion resistant red earth soils.⁷

Lower sections of Condor Creek were cleared for plantation (primarily *Pinus radiata*), from the 1890s until 1961. The geology of the lower sections is mostly Silurian volcanic bedrock, with red and erosion prone yellow soils.

The biggest threat to water quality from Condor Creek is fine sediment and turbidity mobilised during rainfall events, most notably from the Wombat Creek Hill area which is a major source of sediment.

Critical spawning habitat for the Cotter Reservoir population of Macquarie Perch lies on the Cotter River immediately downstream of the Condor Creek junction.

The greatest threats to this spawning ground are barriers that would restrict access, for example, reduced water levels and instream natural barriers to fish passage, and, sedimentation such as that entering from Condor Creek.



Condor Creek upstream of Padovans Crossing with road closure erosion control. Source: University of Canberra



Pierces Creek 200 metres from Cotter Reservoir. Source: Caitlin Roy

LEES CREEK

The Lees Creek headwaters are on the eastern slopes of the Brindabella Range and the western slopes of the Bulls Head Range, to the west of the Cotter River.

Like Condor Creek, the headwater catchment is typified by native forest (wet and dry sclerophyll forests) overlying Ordovician metamorphosed sediments covered in erosion resistant red earth soils. The geology of the lower sections is mostly Silurian volcanic bedrock, with red and erosion prone yellow soils.

PIERCES CREEK

The headwaters of Pierces Creek commence in the Hardy Range to the east of the Cotter River, course through native forest, pine plantation, and natural and assisted regeneration areas, before reaching the Lower Cotter Catchment boundary.

The geology of Pierces Creek sub-catchment is largely Ordovician meta-sediments in the upper reaches turning to Silurian granitoids. Soils of the upper catchment are red earth soils whereas the lower parts are largely unstable brown chromosols.

Following the 2003 bushfires, the Pierces Creek sub-catchment has become exposed to large areas of erosion and gully formation. The creek itself has been heavily impacted by sedimentation of large particles from the granitic soils. This has negative effects on water quality and biological condition including an impact on macroinvertebrates and fish.

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⁷ University of Canberra 2018. Lower Cotter Catchment: monitoring and evaluation framework for the protection of water and ecological values

3.3 Water Context in the Lower Cotter Catchment

3.3.1 HISTORY OF THE COTTER DAM

In 1915 the Cotter Dam was built just upstream of the Cotter River's confluence with the Murrumbidgee River to take advantage of the high quality water naturally filtered by the mountains to Canberra's west.

For over 40 years the Cotter Dam was Canberra's only water supply. Water had to be pumped up hill via reservoirs at Mount Stromlo and Red Hill. As the city grew, so did its water consumption. The dam wall of Cotter was raised in 1951 to increase storage capacity.

Bendora and Corin Dams were built upstream on the Cotter River in the 1960s. Their high montane catchments produced high quality water with the advantage of being gravity fed to Canberra, saving on costs of pumping and water treatment.⁸

With the construction of the Googong Reservoir in 1977, Canberra's dependence on the Cotter Reservoir waned and it was not until 2004, in the aftermath of the 2003 bushfires and prolonged drought, that water was once again drawn from the Cotter Dam.⁹

The realisation that a changing climate would bring with it prolonged periods of drought required an integrated response by government in an effort to secure Canberra's water future.

The Cotter Dam was an important element of that emerging strategy. In 2009, work commenced on enlarging the capacity of the existing dam through the construction of a new 80 metre high dam wall downstream of the existing dam wall structure.

In 2013, the enlarged Cotter Dam was completed, extending the capacity from 4 gigalitres to 78 gigalitres, increasing total water storage capacity for the ACT by 36 per cent.

With the greatly increased storage capacity of the Cotter Reservoir, the significance to the ACT of this drinking water body is considerable and as a direct consequence, the quality and quantity of the stored water requires ongoing attention.¹⁰



Cotter River 1912. Source: Australian National Library



Enlarged Cotter Dam construction. Source: Icon Water.

⁸ ACT Auditor-General's Report, Restoration of the Lower Cotter Catchment, Report No. 3/15

⁹ Government response to PAC Report 31 – Review of the Auditor-General's Report No. 3 of 2015 - Restoration of the Lower Cotter Catchment, December 2016

¹⁰ ACT Auditor-General's Report, Restoration of the Lower Cotter Catchment, Report No. 3/15

3.3.2 LONG-TERM WATER SECURITY FOR THE ACT

Canberra's long-term water future is regarded as moderately secure following major investments in source water infrastructure when coupled with reductions in demand.

Since water restrictions were removed in November 2010, per capita water consumption in Canberra and Queanbeyan has consistently been 35–40 per cent below consumption levels experienced before the introduction of water restrictions in 2002. This is one of the largest sustained water use reductions per capita recorded in Australia.¹¹

Icon Water figures show that in 2016–17 the average water consumption per person per day in the capital was 304 litres, about 40 per cent less than before the Millennium Drought.¹²

The development of operating rules for the source water system is an exercise in balancing the operating cost of running the system against water security risk.

Icon Water has developed sophisticated water resources and economic modeling that is used to determine the optimal operational approach. The model consists of the following elements:

- estimates of the direct costs of supplying water from each source,
- estimates of the cost to the community of experiencing each level of water restrictions, and
- water resources software modelling that estimates the volumes of water supplied to and from each source, plus the frequency and severity of water restrictions under many possible future weather scenarios.

All three elements are regularly reviewed and updated.¹³

Completion of the enlarged Cotter Dam, as well as upgrades to water treatment facilities and infrastructure to withstand drought conditions, have all factored into the ACT's improved water security.

In fact, Icon Water is so confident in the ACT's water security that in June 2018 the contract with Snowy Hydro for back-up water supplies from Tantangara Reservoir was terminated, with Icon Water Managing Director John Knox stating that,

*“even without the Tantangara option, our modelling shows that our water system can withstand the worst drought on record.”*¹⁴

It should be noted, however, that as at 01 September 2018, combined dam levels were at 68 per cent capacity, down from 78 per cent in February 2018.¹⁵

Water supply is cyclical, and drought is on the horizon in the ACT following an announcement earlier this year that the entire state of NSW has been declared drought stricken.¹⁶

While the ACT is in a good position to deal with drought conditions, the Lower Cotter Catchment is a fragile recovering landscape, highly susceptible to fire and other risks which impact water quality.

Extensive measures must be taken to ensure there is adequate investment, monitoring, modelling, evaluation and management of water catchment assets.

3.3.3 SOURCE WATER PROTECTION

Reliance on drawing water from the Cotter Reservoir for drinking water supply is a significant change in Canberra's water distribution network. Renewed focus on restoration and resilience of the Lower Cotter Catchment will be important for ongoing management.

There are many barriers to protecting source water including:

- reservoir retention time,
- water abstraction and treatment, and
- the potential for contamination across the broader distribution system.

The water distribution system in the ACT is a closed network, which limits potential external contamination of water mains.¹⁷ However, management of contamination at a catchment level is a much larger task that requires targeted monitoring and evaluation of water quality and management activities.

Land management and monitoring focussed on reducing contamination is the first, and most important, step in source water protection.

11 <https://www.canberratimes.com.au/national/act/canberras-frugal-water-usage-equivalent-to-1970s-when-city-half-the-size-20170804-gxpf31.html> accessed 2 June 2018

12 Icon Water 2017, Annual Report 16-17

13 Pers. Comm., email from Icon Water, 28 June 2018

14 <https://www.canberratimes.com.au/politics/act/while-one-third-nsw-in-drought-act-has-cancelled-extra-water-licence-20180619-p4zmfl.html> accessed June 24 2018

15 <https://www.iconwater.com.au/> accessed 12 February 2018 and 1 September 2018

16 <https://www.theguardian.com/environment/2018/aug/08/nsw-declared-100-in-drought-as-farmers-fear-relief-package-too-late> accessed 8 August 2018

17 Icon Water Annual Drinking Water Quality Report 2016-17 web.pdf accessed June 6 2018

3.3.4 INVESTMENT IN NATURAL WATER FILTERING SERVICES

Water provides ecosystem services and is in turn affected by other ecosystem services.

Healthy soils, terrestrial environments and aquatic ecosystems help to filter and purify water after it falls as rain and snow, before it flows into rivers and streams, and before it is collected and distributed for human use.

The quality of water can decline significantly when it passes through ecosystems and soils that have been degraded by poor management or disturbed by events such as fire.¹⁸

Collectively, the impact of land management practices such as commercial pine plantations, have profoundly reduced vegetation condition and ecosystem resilience across much of Australia. This is particularly the case where intensive agriculture and forestry have removed and replaced the native overstorey or replaced the understorey structure and composition with exotic trees, pastures and crops.

Intensive agriculture and forestry have modified key functional criteria of soil hydrology, soil nutrients, soil structure, soil biology, the natural disturbance regime, and the reproductive potential of the plant community. These ecosystem changes have, at least in the short term (across decades), promoted higher levels of economic productivity than would otherwise be the case under a cover of native vegetation.¹⁹ However, they have compromised the natural ability of the catchment to filter water.

This prolonged program of disturbance has reduced the natural regenerative capacity of native vegetation to the point that active and costly restoration is now required.

The alternative to investing in restoration and natural filtration is to rely on mechanised water filtration. This can be exceedingly expensive and it often takes several treatments before drinking water guidelines are met.

To reduce the potential for such costs there needs to be up-front investment in nature's services.

Commitment to restoration and associated activities will prioritise catchment health and protect vital water-filtering ecosystems without having recourse to costly end of system services. Examples of this sort of beneficial activity include:

- undertaking management activities to prevent contamination from pesticide,
- minimising sediment run-off, and
- educating land holders and community groups about catchment values.

A similar exercise is being undertaken outside New York in the USA. To fend off the \$6 billion dollar price tag for the construction of a new treatment facility and estimated \$300 million per year for operating costs, the city is implementing extensive watershed management measures. These include water quality monitoring and contamination surveillance to protect the natural filtering abilities of the water catchment and take pressure off expensive and high maintenance treatment options.²⁰

In this example farming communities are being paid for fencing their stock off from watercourses (payments for ecosystem services).

In the Lower Cotter, because it is public land, this is not an expense which will need to be met, but this case study clearly demonstrates the value of ecosystem services to the public, and the fact that they are not free goods.

3.4 Land Use in the Lower Cotter Catchment

3.4.1 HISTORY OF FIRE

Fossil records and charcoal deposits indicate that fire has been an active agent in the Australian landscape for at least 30 million years, with aridity and lightning understood to be the primary cause.²¹

Specifically in this region, little is known about traditional fire practices of Aboriginal people prior to European settlement which resulted in the cessation of traditional Aboriginal burning of Country, and impacted on the transfer of this knowledge to future generations.²²

18 ACT State of the Environment Report <http://reports.envcomm.act.gov.au/actsoe2015/the-report/6-water/6-2-introduction/index.html> accessed 8 August 2018

19 Sayer, J. & C. Margules 2017. Biodiversity in Locally Managed Lands. Land 2017, 6(2)

20 http://smapp.rand.org/ise/ourfuture/NaturesServices/sec1_watershed.html accessed Feb 10 2018 accessed 5 February 2018

21 <https://www.dpaw.wa.gov.au/management/fire/fire-and-the-environment/> accessed 17 September 2018

22 <https://www.dpaw.wa.gov.au/management/fire/fire-and-the-environment/> accessed 17 September 2018



Blue Range pile burns 2018. Source: Parks and Conservation Service, EPSDD

As is demonstrably the case in other parts of the country, it is highly likely that fire was used to stimulate grass and shrub growth, facilitate hunting, and to keep open routes for travel.²³

Fire regimes also changed dramatically with European settlement, with the frequency of fires increasing by more than five times during the period 1850 to 1950.²⁴ It has been suggested that a changed regime began with graziers and stockmen regularly burning the mountain forests to encourage palatable growth for stock, maintain accessibility, and mitigate larger bushfires.²⁵

More recently, the Lower Cotter Catchment has had a history of fire frequently relating to illegal human activity.²⁶

Most of the Lower Cotter Catchment was subject to very high fire severity during the 2003 bushfires and all of the remnant native forest and pine plantations were significantly impacted. Much of the native woodland and forest has re-established through natural sprouting, seed germination or other modes of recovery, while the pine trees have regenerated from a mix of replanting and natural regeneration.²⁷

After the fires, “we coined a new phrase, the ‘green fur look,’ to describe the epicormic regrowth of the eucalyptus, and witnessed tonnes of new top-soil deposited from the mountains onto the alluvial plains of the valley floors. A case of natural history repeating itself.”²⁸

The bushfires of January 2003 elevated the importance of fire management in conservation reserves. Much of the discussion derived from the expectation that bushfire threat can be ‘tamed’ and concerns about whether unplanned fires can be controlled and extinguished.

This increased interest and commitment to management of fire is based on a twin approach:²⁹

- fire management developed over the last 50 years of fire suppression (aided by major advances in technology), and
- prescribed hazard reduction burning at low intensities.

It is likely that large-scale, high intensity fires will occur again under future climate change scenarios, while planned fire is intended to be introduced more frequently as a management tool.³⁰



Epicormic regrowth post 2003 fires. Source: Mark Butz

23 Flood, J. 1980. The Moth Hunters: Aboriginal Prehistory of the Australian Alps

24 ACT Government, Lower Cotter Catchment Reserve Management Plan 2018

25 Butz, M. 2003. Conservation Management Plan for Shannons Flat and Blundells Flat ACT

26 ACT Government, Lower Cotter Catchment Reserve Management Plan 2018

27 Daniell, T. & I. White, 2005. Bushfires and their implications for management of future water supplies in the Australian Capital Territory

28 Brett McNamara quoted in Kaufman, R. 2006. Remembering the Lost Places. Australian Alps Liaison Committee

29 Office of the Commissioner for Sustainability and the Environment 2015. State of the Environment Report, ACT

30 Pausas J. & J. Keeley 2009. A Burning Story: The Role of Fire in the History of Life. *BioScience*, Volume 59, Issue 7

ISSUES IN RESPECT OF FIRE RISK MANAGEMENT IN THE LOWER COTTER CATCHMENT

Associate Professor Janet Stanley, Principal Research Fellow, Melbourne University

Climate change is exacerbating the incidence of bushfires and increasing the risk that a fire will become large and dangerous.^{31 32} Recent work suggests that there are approximately 240,000 landscape fires occurring annually in Australia.³³ While climate will increase the risk of a bushfire becoming large, it is thought that 85 per cent to 90 per cent of fires are directly or indirectly ignited by human activity.

A couple of characteristics in the Lower Cotter Catchment area raise serious concerns should a bushfire occur. These relate to:

- the need to preserve the volume and quality of water, both threatened by fire,
- the proximity of the catchment area to both substantial forest and urban areas, with the risk of fire moving to or from these neighbouring areas, and
- the need to preserve the ecology and recreational value of the catchment area.

To reduce the risk of an uncontrolled fire, a complete range of prevention measures is required to cover all ignition risks, rather than a sole reliance on environmental modification. Critically, climate change mitigation will reduce the increasing risk of bushfires into the future. However, there are a number of localised measures that can be taken to reduce current risk, especially recognising the many access points to the catchment and the history of arson in the area.

There are many roads and tracks throughout most of the catchment area that offer access to people, risking the lighting of 'reckless' or 'accidental' fires, such as from camp fires, vehicles and machinery that generate sparks. Uncontrolled access also risks intentional fires being lit. Access to the area should be minimised and closely monitored (also with the use of cameras in vulnerable areas), especially limiting isolated access points that may offer seclusion to an intentional fire-lighter and where it may be harder and longer for fire-fighting vehicles, to reach the fire.

Intentional fire-lighters can also enter by foot, motor bikes and bicycles. Arguably, trail bike riding should be limited on the grounds that this provides easy access away from people and is an activity largely undertaken by youth who are the highest group of people who light illegal fires. However, discretion is

needed in advertising this probably unpopular restriction, to avoid revenge activities.

Mountain bike riding is less of a hazard but should be reviewed as being an unsuitable activity in the catchment area as it has a tendency to open up tracks and widen existing ones, facilitating access for fire-lighters. A counter argument is that encouraging this type of passive recreation could provide a level of community oversight and incidental surveillance, potentially decreasing the likelihood of illegal activities.

Isolated areas are more likely to be used to dump cars and rubbish, and well as a venue for parties and illegal fireworks. All dumped vehicles and rubbish should be removed, as these are commonly used as a source for ignition, and vehicles with this perceived intention prevented from entering the area, as stolen goods, are commonly dumped and immediately ignited to destroy evidence. This is discussed in more detail in Chapter 6.

All access points should be closed on high fire risk days. It is recognised that the closure of roads may also prevent fire-vehicle access, thus opportunities and resources for helicopter access to the catchment should be increased.

Uriarra Village could potentially be a problem for fire risk, especially the many tracks into the catchment area that are close to the village, as the risk of an intentional fire being lit is much higher in forested areas close to urban locations. Most of these tracks should be closed. Findings suggest that many fires are lit within 4 kilometres of the person's residential location. Similarly, for this reason, further urban development of Canberra should not occur closer to the catchment area. It is intended that Molonglo Valley will eventually house up to 55,000 people, an issue of serious concern in relation to fire risk.

An important means of monitoring fire related activity is to use the eyes of the community. Encouraging the reporting of suspicious behaviour to Crime Stoppers is a highly valuable means of fire prevention as members of the community are those most likely to be aware of who is engaging in problem behaviour. Marketing and communication to encourage reporting, and education of what to report and where, should be undertaken in collaboration with Crime Stoppers ACT.



31 Union of Concerned Scientists 2017. Confronting Climate Change in Oregon: Current Impacts and future risks, <http://www.ucsusa.org/sites/default/files/attach/2015/03/ucs-confronting-climate-change-oregon-2015.pdf>

32 Hughes L. & D. Alexander 2017. Climate Change and the Victoria Bushfire Threat: Update 2017, Climate Council of Australia Ltd., Australia

33 Steering Committee for the Review of Government Service Provision 2016. Report on Government Services 2016, vol. D, Emergency Management, Productivity Commission, Canberra, Australia

3.4.2 AGRICULTURE

There is evidence of Aboriginal land management in and along the reaches of the Cotter River, dating back tens of thousands of years.

Some examples include seasonal food sources such as Yam Daisy, wattle seed, fish, crayfish, yabbies, platypus, water fowl, terrestrial mammals, and Bogong Moths in the summer months.³⁴

Aboriginal people were displaced from their Country in the 1820s to the 1850s when settlers arrived and established farms in the area. At that time native vegetation was cleared from the lower slopes to promote grazing of sheep and cattle.

For almost a century pastoral land use, along with the effects of rabbit plagues, denuded most of the vegetation and left the soils vulnerable to severe erosion.³⁵

The Lower Cotter Catchment has been subject to a much higher level of disturbance as a result of human activity than the upper sub-catchments. Over 3000 hectares of the approximately 6000 hectare sub-catchment was cleared for grazing purposes. Overgrazing resulted in serious erosion which was further exacerbated by rabbits. In order to protect the catchment, freehold grazing leases within the catchment were terminated by 1913.³⁶

Declaration of Canberra as the site for the national capital in 1911, and the need to set aside land for a water supply catchment, resulted in compulsory acquisition of the pastoral leases within the Lower Cotter Catchment area.

Removing livestock grazing, replanting cleared areas to pine plantations, and closing large areas of the catchment to general public use, were among measures taken to ensure the protection of the catchment for the future.



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Clearing in the Cotter Catchment. Source: National Library of Australia

³⁴ ACT Government, Lower Cotter Catchment Reserve Management Plan 2018

³⁵ ACT Government, Lower Cotter Catchment Reserve Management Plan 2018

³⁶ ACT Government, Lower Cotter Catchment Strategic Management Plan 2007

3.4.3 COMMERCIAL FORESTRY

The Cotter Dam was completed in 1915 and concerns over the high levels of sediment entering the dam led to the commencement of pine (*Pinus radiata*) plantations on the eroding areas within the Lower Cotter Catchment in 1926.³⁷

Initially, the plantation areas were focussed around the reservoir but by 1931 this had extended to 3000 hectares of pines to stabilise the landscape. Over time, more pines were planted and an ACT forestry industry commenced.

Forestry increased to cover more than 4000 hectares at its peak, however, the practice stalled due to community concern about plantation impacts on water quality. Pressure to reduce the commitment to forestry receded with the completion of Bendora Dam in 1961 and Corin Dam in 1968, whereby water abstraction from the Cotter Reservoir was suspended for over 30 years.³⁸

ACT Forests continues to manage pine plantations in the Lower Cotter Catchment, and other larger pine plantations in adjacent areas.



*Clearing in the Cotter River Catchment area, 1958.
Source: National Archives of Australia*



*Commercial pine forest in the Lower Cotter Catchment, 1963.
Source: National Archives of Australia*

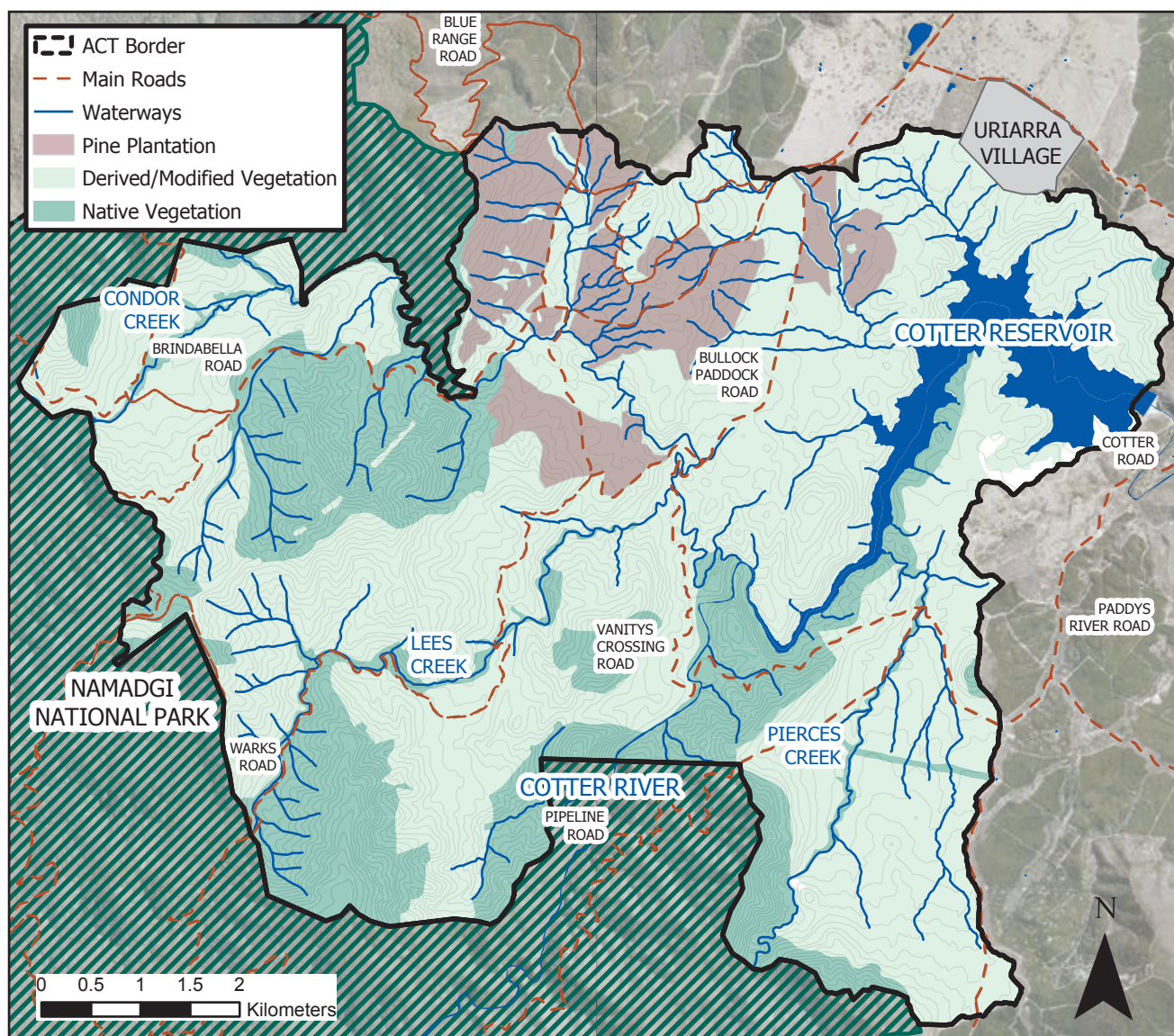


Dense pine wilding regrowth in the Lower Cotter Catchment. Source: Ian Falconer

³⁷ ACT Government, Lower Cotter Catchment Reserve Management Plan 2018

³⁸ Actew AGL 2009, Environmental Impact Statement, Volume 1

VEGETATION IN THE LOWER COTTER CATCHMENT 2018



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Map developed by Serena Farrelly and Jack Wales. Source: Office of the Commissioner for Sustainability and the Environment 2018.



Example of derived/modified vegetation. Source: Caitlin Roy



Example of native vegetation. Source: Kate Auty

3.4.4 BUILDING RESILIENCE: WATER CATCHMENT MANAGEMENT AND NATIVE REVEGETATION

The Millennium Drought and 2003 bushfires triggered a resetting of priorities in natural resource management across the ACT. A decision was made to restore the Lower Cotter Catchment to native vegetation to ensure the protection of water quality in the Cotter Reservoir.

As the area recovers and functioning natural ecosystems are restored over the longer term, it is intended that

the Lower Cotter Catchment will be incorporated into Namadgi National Park. This will complete the comprehensive protection of the entire Cotter catchment and safeguard Canberra's supply of clean, high quality water into the future.³⁹

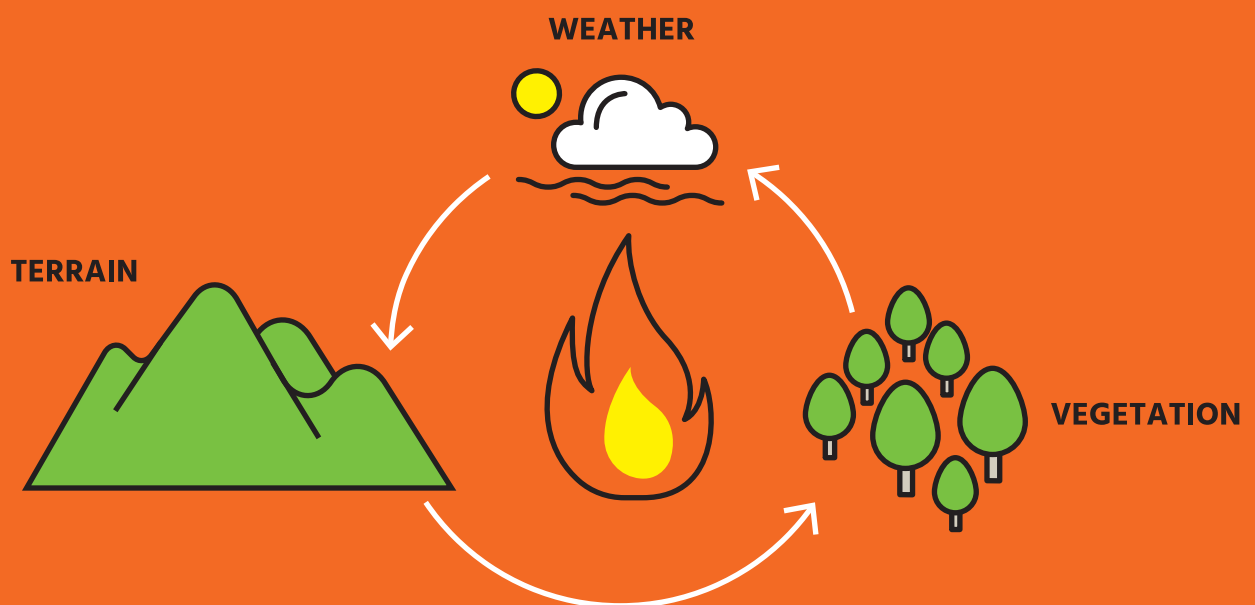
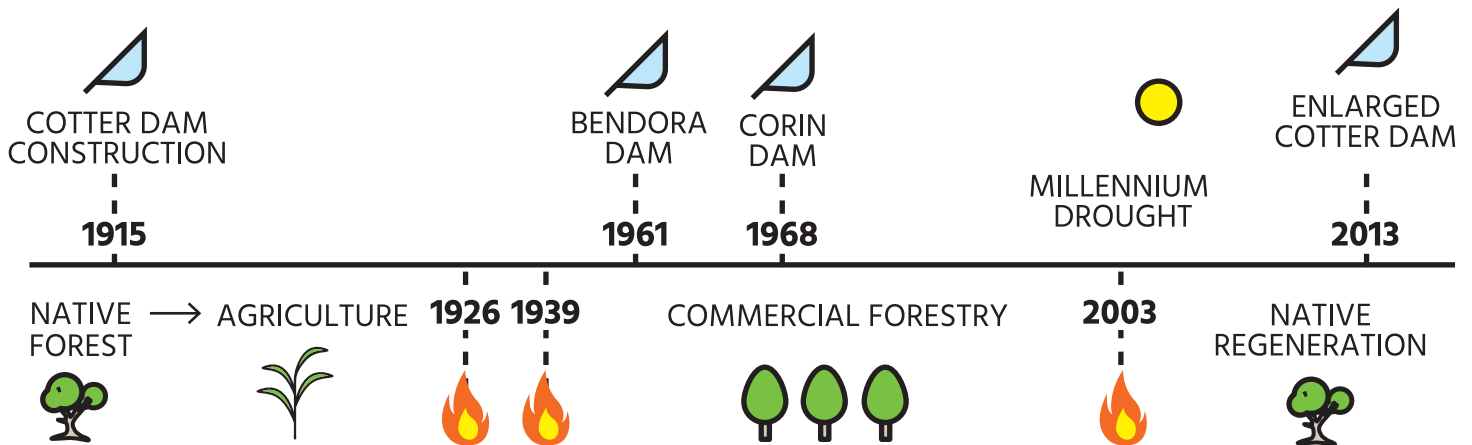
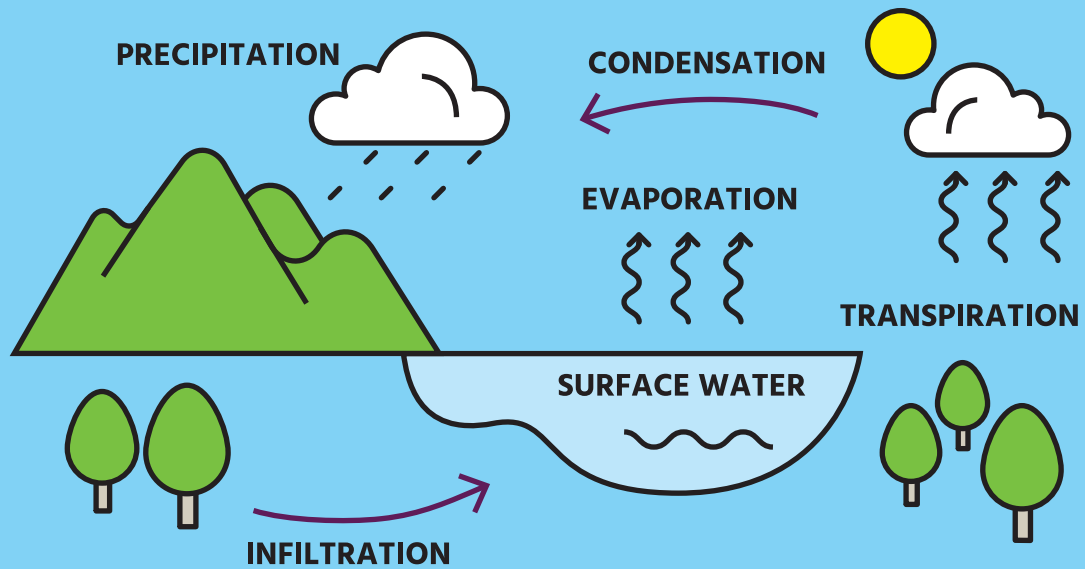
While incorporation of the Lower Cotter Catchment into Namadgi National Park will be a symbolic milestone reflecting prolonged restoration efforts and achievement of ecosystem resilience, this must not be done prematurely.

“You can’t compare fire management for Lower Cotter Catchment and Namadgi National Park. Not one size fits all. Firstly, because of the geographic location, being the proximity to the reservoir and the community. Secondly, because they are totally different environments. Namadgi is a pristine piece of wilderness, an environmental asset that responds well to fire. Lower Cotter is a vulnerable recovering landscape.”

Dominic Lane, Commissioner, Emergency Services Agency.

³⁹ ACT Government, Lower Cotter Catchment Reserve Management Plan 2018

WATER CYCLE



FIRE CYCLE

LESSONS IN SYSTEM RESILIENCE AND ADAPTATION FROM THE LOWER COTTER CATCHMENT

Dr David Freudenberger (left) and Dr Richard Thackway (right), Honorary Fellows, Fenner School of Environment and Society, Australian National University (ANU)



For the past five years I've taken classes of 30–40 ANU students out to the Cotter for a case study examination of a complex socio-ecological system. That's an academic way of looking at the Cotter's history of changing social values and subsequent changes in land uses. With some training from my colleague Richard Thackway, some historical data he compiled, and field trips to the upper and lower Cotter, my students conducted a rapid assessment of the Cotter's resilience using Richard's Vegetation Assessment State and Transitions (VAST) analysis framework⁴⁰ and the Resilience Alliance's Workbook for Practitioners.⁴¹

This case study helped them develop the necessary skills to then conduct a resilience assessment of a landscape of their choice anywhere in the world. The desired learning outcome was for students to rapidly

understand that all landscapes are shaped by human values and are highly dynamic in space and time.

As you'll see from our VAST assessment below, the Cotter is indeed such a landscape.

Major environmental disturbances such as bushfire and land use changes have greatly affected the ecological function of the Lower Cotter Catchment as summarised in Figure 1.

Figure 1. Likely changes in landscape function of the Lower Cotter Catchment over the past 130 years due to major changes in social values and associated land uses. Chronology of events compiled primarily for the Blundell's Flat area of the Cotter based on Butz⁴² and Thackway.⁴³ Assessment methodology as per Thackway and Freudenberger.⁴⁴

Figure 1

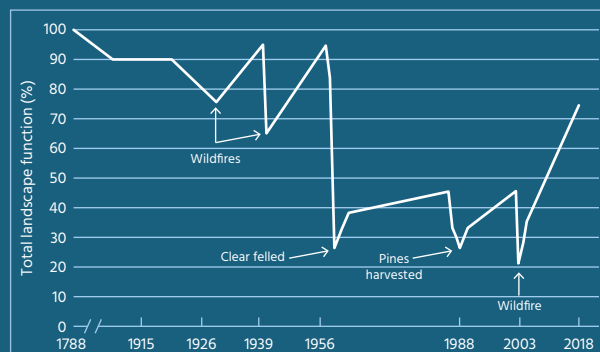


Figure 2

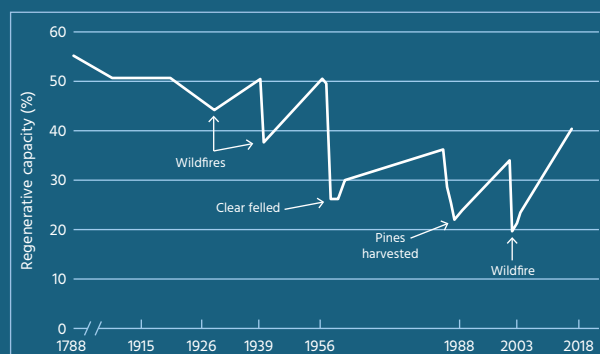


Figure 3

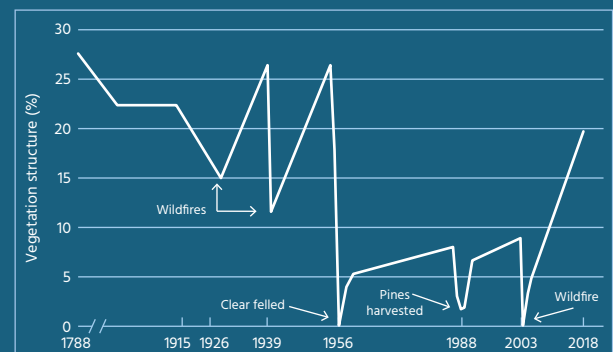
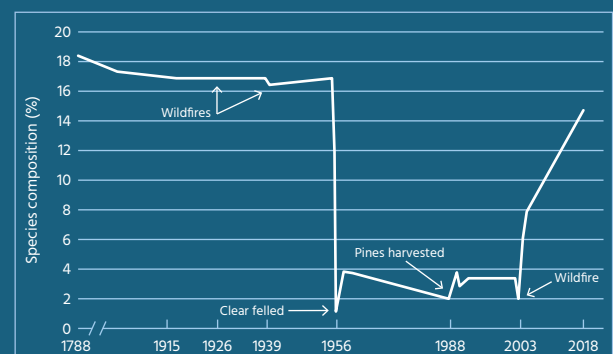


Figure 4



⁴⁰ Vegetation Assessment State and Transitions; <http://vasttransformations.com/>

⁴¹ Resilience Alliance's Workbook for Practitioners (<https://www.resalliance.org/resilience-assessment>).

⁴² Butz, M. 2009. Conservation management plan: Blundells Flat and Shannons Flat, ACT, Part A-H. Report provided to the ACT Government through the ACT Heritage Grants Program – HG04/22

⁴³ Thackway, R. 2013. Transformation of Australia's Vegetated Landscapes, Blundells Flat, ex-coupe 424, ACT. Australian Centre for Ecological Analysis and Synthesis, University of Queensland, Brisbane

⁴⁴ Thackway, R. & Freudenberger, D. 2016. Accounting for the drivers that degrade and restore landscape functions in Australia. *Land*, 5, 40

This catchment has clearly undergone dramatic and rapid changes in landscape functionality which reflects changes in how the natural regenerative capacity (Fig. 2), vegetation structure (Fig. 3), and vegetation composition (Fig. 4) have changed over the past 130 years. In the early years of European settlement the catchment was affected by ringbarking and clearing for grazing, then affected by large bushfires (1926 and 1939).

This likely caused a rapid impairment of landscape function, particularly an increase in erosion and river sediment due to the rapid loss of vegetation cover on steep slopes.⁴⁵

However, this impairment was likely temporary; function rapidly recovered as native vegetation quickly reestablished.

The greatest and longest changes in landscape functionality occurred when the native vegetation was replaced by the establishment of a pine plantation. This land use change reflected Federal Government policy to develop a national softwood plantation industry to meet the demand for timber products from a rapidly growing economy and population. Pine plantations were also considered to be a solution to chronic soil erosion in the catchment. Once established, the pines likely reduced rainfall run-off, erosion and turbidity, but overall function remained low due to the loss of natural woodland structure (Fig. 3.) and species composition (Fig.4).

Under pines there was a second rapid decline in landscape functionality when the first rotation was harvested and the slopes cultivated for planting-out the second rotation. By 2003, some functionality had recovered as the second rotation grew, but species composition remained very low due to the dominance of *Radiata* pine (Fig. 4).

The firestorm of January 2003 incinerated the pine plantation reducing vegetation structure to ash and charred trunks. After rainfall events, high levels of turbidity were recorded in the Cotter Dam.⁴⁶ Dead pine removal and soil cultivation commenced shortly after the fire in preparation for replanting pines.

However, in 2006 the ACT Government decided to cease replanting pines in favour of allowing the establishment of native vegetation across most of the catchment. Only a few hundred hectares have been planted out to trees and shrubs by volunteers or contractors. The rest of the catchment has been allowed to regenerate native vegetation naturally.

Since the 2003 fire, a remarkable recovery of landscape function has occurred (Fig. 1). Even after decades of pine plantation, the capacity of the native vegetation to regenerate (Fig. 2) is quite apparent. The overall functionality of the Lower Cotter never went

below 20 per cent (Fig. 1). Because this regenerative capacity remained, even though vegetation structure and composition was reduced to nearly zero at the time of plantation establishment (Figs. 3&4).

Somehow native seed remained in the soil during the decades of pine plantation, or remnant vegetation was close enough for much of the Lower Cotter to naturally regenerate following the 2003 fire.

The recovery of the Lower Cotter is not complete. Total landscape functionality remains below likely pre-European levels (Fig. 1).⁴⁷ The vegetation structure of the Lower Cotter is still quite different to nearby less-disturbed forest and woodland. The trees are all about the same young age (~15 years) and small in height unlike the mix of ages and heights found nearby.

In addition, the species composition of the Lower Cotter remains significantly different to pre-European composition. Invasive weeds are now ubiquitous across the Lower Cotter: the most obvious is blackberry. But such weeds enhance landscape functionality by providing an often dense understory to the regenerating trees. Many of the present non-native plant species within the catchment are likely to be a permanent component of the system.

Nevertheless, we deem the Lower Cotter to be a highly resilient socio-ecological system. The Cotter was no doubt shaped by thousands of years of Aboriginal use and stewardship, then greatly altered by 150 years of colonial and post-colonial values and associated land uses.

Bushfires, some accidentally ignited by stockmen's campfires,⁴⁸ have repeatedly reduced landscape functionality, but this system does rapidly recover. On top of fire, extensive livestock grazing, some timber harvesting, and rabbit invasion further accelerated the loss of vegetation cover and subsequent soil erosion. The establishment of a pine plantation was considered at the time to address erosional problems in the catchment, but pine establishment, roading and harvesting operations have seen periods of low landscape functionality.

The 2003 firestorm and associated drought provided shocks to this socio-ecological system.

The loss of the pine plantation allowed other options to be considered.

Due to the slow variables of urban population growth and climate change, the water catchment and storage values have now become greater than softwood plantation values. The catchment has been allowed to revert to native vegetation to enhance water values.

This represents a remarkable reversion and illustrates the dynamism of history at Canberra's suburban fringe.

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45 White, I., Wade, A. Worthy, A., Mueller, N., Daniell, T. & Wasson, R. 2006. The vulnerability of water supply catchments to bushfires: impacts of the January 2003 wildfires on the Australian Capital Territory. *Australian Journal of Water Resources*. 10, 179-194

46 White, I., Wade, A. Worthy, A., Mueller, N., Daniell, T. and Wasson, R. 2006. The vulnerability of water supply catchments to bushfires: impacts of the January 2003 wildfires on the Australian Capital Territory. *Australian Journal of Water Resources*. 10, 179-194.

47 Thackway, R. & Freudenberger, D. 2016. Accounting for the drivers that degrade and restore landscape functions in Australia. *Land*, 5, 40

48 White, I., Wade, A. Worthy, A., Mueller, N., Daniel, T. and Wasson, R. 2006. The vulnerability of water supply catchments to bushfires: impacts of the January 2003 wildfires on the Australian Capital Territory. *Australian Journal of Water Resources*. 10, 179-194.

IMPORTING ENGINEERS: BETTONGS BELONG



Eastern Bettong. Source: Mulligans Flat Woodland Sanctuary

Like many small marsupial species, the Eastern Bettong (*Bettongia gaimardi*) became completely extinct on Australia's mainland in the 1920s. This was following predation from introduced species and systematic land clearing. Nearly 100 years on, bettongs from the only remaining wild source population in Tasmania have been reintroduced to the ACT.

The local population of bettongs is now thriving thanks to a captive breeding program emerging from Tidbinbilla Nature Reserve and Mulligans Flat. This ACT program has resulted in the most successful reintroduction of the species in Australian history.⁴⁹

*"Bettongs are understood to play an important role in restoring the ACT's grassy box-gum woodland, which is a threatened ecological community. As they dig for truffles to eat they are working as 'ecosystem-engineers'. These 'engineers' improve soil conditions by increasing nutrient levels and water infiltration, creating better habitat for other organisms."*⁵⁰

In 2016 a trial was conducted, releasing a number of bettongs into the wild of the Lower Cotter Catchment. As ecosystem engineers, the recovering

landscape of the Lower Cotter Catchment is an ideal environment for bettongs to work their magic.⁵¹

Without the protection of secure fencing, these bettongs are competing with habitat loss, 1080 poison, and the risk of predation from feral animals such as foxes and cats. The trial included pest control prior to release, rigorous monitoring, and ongoing investment to assess its success. Monitoring was effected by radio tracking collars, surveillance cameras, and regular welfare health checks. The trial has recently concluded and is an important milestone in providing information about reintroduction of the species into the wild.

The Tidbinbilla Nature Reserve bettong breeding program has been an important foundation to maintain genetic diversity as well as providing an insurance population for Mulligans Flat and future reintroductions into the wild.

With unique and demonstrable benefits to ecosystem services and biodiversity conservation, it is fair to say that Eastern Bettongs belong here in the ACT.

49 <http://www.environment.act.gov.au/home/Bush-Capital/bettongs-bounce-back> accessed 10 June 2018

50 https://www.cmtedd.act.gov.au/open_government/inform/act_government_media_releases/esdd/2017/have-your-say-on-protecting-canberra-bettongs accessed 22 August 2018

51 <http://www.abc.net.au/news/2017-04-02/eastern-bettongs-breeding-in-the-wild-on-mainland-australia/8406432> accessed 13 June 2018

3.5 Cotter and the Canberra Community



*Greening Australia seedlings for revegetation projects.
Source: Caitlin Roy*

Community engagement and recreation in the Lower Cotter Catchment has been documented and regarded as an integral part of Canberra's history. This community involvement is heightened compared to some other reserves in the ACT due to its diversity, accessibility, and proximity to residential areas.

While brumby running and swimming were once commonplace in the catchment, current recreational activities include four wheel driving, mountain biking, and walking. Other community groups continue to utilise the catchment for research and education purposes.

Following the 2003 bushfires there was a huge surge of community investment in rehabilitating the catchment. The loss of life and extensive natural damage prompted unprecedented community spirit in Canberra, attracting a remarkable level of volunteer assistance and effort, donations, and an outstanding government-facilitated recovery process.⁵²

A native replanting program jointly prepared by government and community was carried out by contractors, community volunteer groups, and individual volunteers from 2007 to 2011. Nearly 15,000 volunteers

spent more than 47,000 hours planting over 306,000 trees and shrubs over 500 hectares.

In fact, replanting of the Lower Cotter Catchment is the largest community engagement project ever recorded in Australia. At one point, one person in 50 of the total population of Canberra and the surrounding region was involved in 'regreening' the Cotter.⁵³

Other groups, such as the Yurung Dhaura (meaning Strong Earth), Waterwatch, Southern Region Catchment Group and Friends of Aboreta also have a longstanding interest in the Lower Cotter Catchment.

Communities that regularly visit protected natural areas feel a sense of stewardship and seek opportunities to take on nurturing responsibilities of this community resource.

The Standing Committee on Public Accounts Review of the Auditor-General's Report No. 3/2015 picked up on this theme and recommended that ACT Government finalise the Lower Cotter recreation strategy and consider extending the program of native planting and habitat restoration for the Lower Cotter Catchment in partnership with the local community and community-based organisations and groups.

The Reserve Management Plan 2018 acknowledges the significant contribution that volunteers have made to land management programs in the Lower Cotter Catchment and commits to further encourage and support volunteer involvement. This includes actions to:

- develop and implement education and communication strategies to improve community knowledge about the values of the Lower Cotter Catchment, appropriate use, and the importance of access restrictions in protecting water quality,
- continue to support community involvement and input from Aboriginal groups in revegetation and other environmental improvement activities,
- develop and implement a strategy to encourage new and expanded volunteer participation in restoration activities, citizen science and research projects,
- enhance partnerships with Aboriginal groups in managing the reserve, and
- enhance partnerships with neighbours in managing reserve boundaries.

With increasing population numbers and climate change impacts, enhancing community custodianship of the Lower Cotter Catchment is critical to long-term community and catchment health. This will be addressed in more detail in Chapter 6 of this report.

⁵² Bartlett, T., Butz, M., Kanowski, P. 2003. Engaging the Community in Reforestation Following the Canberra Bushfire

⁵³ Per comms. Meeting with Senior Project Manager, Greening Australia, January 2018.

4.

Evaluation of Ecological Restoration 2015–18



4.1 Ecological Restoration Evaluation: Purpose and Approach

The Auditor-General's Report, Restoration of the Lower Cotter Catchment Report No. 3/2015,¹ included 12 recommendations. Recommendation 12 was for the Commissioner for Sustainability and the Environment to evaluate restoration against management goals outlined in the reserve management plan and report on priorities for the next decade.

The Lower Cotter Catchment Reserve Management Plan 2018 was presented to the ACT Legislative Assembly by Minister Gentleman in February 2018.

Consistent with the *Planning and Development Act 2007*, the reserve management plan contains three core management objectives defined for a reserve set aside primarily for the protection of water supply. These are:

- to protect existing and future domestic water supply,
- to conserve the natural environment, and
- to provide for public use of the areas for education, research and low impact recreation.

This evaluation assesses restoration for the period 2015–18 against these three core management objectives, as well as reviewing the implementation status of the Auditor-General's recommendations, and the Standing Committee on Public Accounts recommendations as they relate to the reserve management plan.

This Evaluation broadly considers:

1. The implementation status of the recommendations outlined in the Auditor-General's Report and their ongoing importance.
2. The implementation status of the Standing Committee on Public Accounts' Report recommendations and their ongoing importance.
3. Whether there has been improvement in the ecological condition of the Lower Cotter Catchment from 2015–18, demonstrated by comparative assessment and science-based evidence.
4. Whether restoration has occurred against management objectives defined for a reserve set aside for the protection of water supply, demonstrated by comparative assessment and science-based evidence.

Consistent with the terms of recommendation 12, this evaluation provides a fresh critical analysis of the opportunities that remain to ensure achievement of better practice restoration outcomes for the Lower Cotter Catchment. The observations of this office set out at section 4.2 in this chapter canvass these further opportunities with a view to ensure alignment between forward restoration priorities and the enabling support required by the ACT Public Service and the Government.

Methodology for undertaking this Evaluation:

- review the Auditor-General's Report and Standing Committee on Public Accounts' Report recommendations,
- review existing science and available research documentation,
- refine the project plan, scope and methodology,
- establish an Expert Reference Group with expertise in water quality, ecological restoration, ecology, fire management, erosion (geomorphology) to provide technical expertise,
- conduct fieldwork with initial information requests and site visits,
- identify key gaps, advise Expert Working Group and seek feedback,
- provide a comparative assessment of restoration progress since 2015,
- develop an integrated monitoring framework to evaluate management actions in the reserve management plan for the next ten years and beyond,
- provide regular updates and seek feedback from key stakeholders throughout the project, and
- based on the above, identify priorities for the next ten years including a monitoring and reporting logic that can support long-term restoration efforts and outcomes.

A monitoring and evaluation framework, discussed in Chapter 5, has been developed for the purpose of reviewing management activities contained in the current reserve management plan, as well the impact of other emerging environmental and economic changes.

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¹ ACT Auditor-General's Report, Restoration of the Lower Cotter Catchment Report No. 3/2015.

EXPERT REFERENCE GROUP MEETINGS



Expert Reference Group Meeting 1, November 2017. Source: Caitlin Roy



Expert Reference Group field trip to Lower Cotter Catchment with Parks and Conservation Service. Source: Kate Auty

4.2 Review of the Implementation Status of Auditor-General’s Report Recommendations

4.2.1 OVERVIEW

Following the Auditor-General’s Report, there have been two ACT Government responses tabled in the Legislative Assembly. In both responses, all twelve recommendations were agreed to.

At the time the Auditor-General’s Report was finalised, the two primary ACT Government directorates’ responsible for implementing recommendations were the then Territory and Municipal Services (TAMS) and Environment and Planning Directorate (EPD). Subsequent changes to the Administrative Arrangements approved under the *Australian Capital Territory (Self-Government) Act 1988 (Cth)* and the *Public Sector Management Act 1994* have resulted in the expansion of EPD into the Environment, Planning and Sustainable Development Directorate (EPSDD), which includes the ACT Parks and Conservation Service (PCS), and the replacement of TAMS with Transport Canberra and City Services (TCCS).

These changes have affected which directorate, and in some cases, which business area is responsible for funding, delivery, and overall responsibility for implementation of initiatives to address the Auditor-General’s recommendations.

The most recent ACT Government Response Progress Report to the Legislative Assembly in February 2017 stated that five of the twelve recommendations were complete, with the remaining seven in progress or nearing completion.

Recognising the ongoing relevance of the Auditor-General’s recommendations to the priorities canvassed by the reserve management plan, this restoration evaluation has included a review of the current implementation status of the recommendations.

All records associated with the internal scrutiny of the implementation of the Auditor-General’s recommendations have been provided to this office, and have been thoroughly reviewed with care. This includes statements of assurance and supporting evidence provided to the EPSDD Audit Committee relating to the closure of recommendations.

Subsequent to the latest Government Response, this review has identified nine recommendations that are considered to be complete, with three recommendations remaining overdue for completion and requiring urgent attention.

However, this review also provides a consolidated assessment of extended implementation activities or initiatives that could be undertaken in relation to eight of the nine completed recommendations consistent with the spirit and intent of the Auditor-General’s Report, as well as how they relate to management priorities outlined in the reserve management plan. The review has noted both the opportunities for renewed focus and the nature and scope of any additional funding required to drive further improvements.

In the following commentary, a clear distinction has been made where additional or ongoing attention is required to comply with Government Response commitments, or to satisfy the intent of the Auditor-General’s recommendations.

The preliminary findings of this review were presented at each Expert Reference Group meeting, at the Lower Cotter Catchment Implementation Coordination Group meeting on 3 July 2018, and provided to relevant stakeholders throughout the course of this evaluation.

Traffic light indicators have been used to reflect the implementation status of recommendations as at 31 October 2018.

STATUS	RESPONSIBILITY
Green	Recommendation met, no ongoing attention required
Blue	Recommendation met but with opportunities for additional initiatives to be considered
Amber	Initiatives in progress that require ongoing attention
Red	Initiatives outstanding that require urgent attention

4.2.2 IMPLEMENTATION STATUS OF AUDITOR-GENERAL'S REPORT RECOMMENDATIONS – SUMMARY FINDINGS

Over three years on from the release of the Auditor-General's Report, a number of recommendations remain incomplete.

Development of a Code of Minor Public Works addressing recommendations 1, 3 and 4 is overdue and urgent attention is required.

Recommendations 5, 6, 7, and 8 relating to governance arrangements are considered to be complete, though require additional attention to meet the intent of the Auditor-General's recommendations, as well as ongoing and additional resourcing in relation to the reserve management plan.

Operational recommendations 10, and 11 are considered to be complete and recommendation 9 is in progress and on track for completion. However, all three of these recommendations require prolonged or additional treatments, regular review and ongoing funding to uphold the intent of the Auditor-General's recommendations.

The Auditor-General's Report into the Lower Cotter Catchment served to focus attention on the importance of delivering effective and integrated land management for this important water catchment area. This has only been achieved in part to date.

As a matter of priority, ongoing commitment and investment is required across ACT Government to see the outstanding recommendations through to completion. Renewed vigour should be applied where recommendations have been identified as requiring additional and ongoing attention.



Road remediation works. Source: Caitlin Roy

4.2.3 IMPLEMENTATION STATUS OF AUDITOR-GENERAL’S REPORT RECOMMENDATIONS

AUDITOR-GENERAL’S RECOMMENDATION 1

A Code of Potable Water Catchment Management, to direct land management activities in the Lower Cotter Catchment, should be developed in consultation with: Territory and Municipal Services, Icon Water, the Environment and Planning Directorate and the Environmental Protection Authority, by December 2016.

(The Code of Potable Water Catchment Management could be based on a review of the ACT Code of Forest Practice 2005 and be used as a standard and a condition contained in environmental authorisations for the Lower Cotter Catchment. It should be consistent with the Australian Drinking Water Guidelines and consistent with provisions of the TAMS and ActewAGL, Code of Practice: Practical guidelines and standards for co-operation for maintenance works.)

Government response

Response: Agreed

Action: EPSDD

Due date: July 2017

Implementation responsibility

Implementation: EPSDD

A Code of Potable Water Catchment Management is being developed by EPSDD in consultation with Icon Water and the Environment Protection Authority. This will feed into the overarching Code of Minor Public Works which is under development and overdue for completion. Refer to implementation status of Auditor-General’s recommendation 3 for more detail.

Status

Initiatives outstanding that require urgent attention



Condor Creek turbid after rain. Source: Ian Falconer

AUDITOR-GENERAL'S RECOMMENDATION 2

The purpose and intention of the Management Agreement between the Conservator of Flora and Fauna and Icon Water (ActewAGL Distribution)—as it relates to the Lower Cotter Catchment—should be reviewed by the Conservator to determine if the agreement should specifically exclude the Lower Cotter Catchment.

(There may be no substantial basis for the inclusion of the Lower Cotter Catchment, as its inclusion in the agreement is only needed if Icon Water's actions might conflict with the management objectives for the catchment, in particular, protecting the water supply. If the Conservator considers that an agreement is necessary, the reasoning for including the Lower Cotter Catchment should be documented in the agreement being developed.)

Government response

Response: Agreed

Due date: Immediate

Implementation responsibility

Implementation: EPSDD

A Site Management Agreement dated 20 January 2017 between the Conservator of Flora and Fauna, EPSDD and Icon Water is now in place and applies to all areas of land in the Territory where Icon Water retains assets including the Lower Cotter Catchment. The Agreement outlines the approval process for maintenance works carried out by Icon Water and requires Icon Water to submit proposals for new works through the normal planning and environmental protection approval process.

Status

Recommendation met, no ongoing attention required

Observations

Under the provisions of the *Nature Conservation Act 2014* the Agreement outlines the environment approvals environment for maintenance works carried out by Icon Water.

The Agreement relates to inspection and maintenance activities, though it does not relate to any new developments or installation of new assets. New works are to be dealt with on a case by case basis and would be the subject of either a new development application (including any environmental assessments required under planning legislation) or a separate licence under the Act.

Representatives from ACT Government and Icon Water will meet bi-annually (or as otherwise agreed by both parties) to discuss procedures under the Agreement, including:

1. review of performance of both parties against performance indicators set out in Section 4 of the Agreement,
2. appropriateness and effectiveness of performance indicators, and
3. areas for better collaboration and alignment of activities.

The Agreement will remain in place until superseded by a subsequent agreement and must be reviewed within five years of the date signed, being 20 January 2022, unless prior review is instigated in writing by either party.

The adoption of this Agreement meets recommendation 2 of the Auditor-Generals Report.

AUDITOR-GENERAL'S RECOMMENDATION 3

The ACT Code of Practice which guides maintenance works on Controlled Land should be implemented by the Territory and Municipal Services Directorate and Icon Water, giving particular attention to the information-sharing and approval processes for annual operations plans and works plans.

(If the Conservator of Flora and Fauna specifically excludes the Lower Cotter Catchment from the Management Agreement (recommendation 2) then Icon Water and Territory and Municipal Services Directorate should develop a Memorandum of Understanding to integrate their activities using the ACT Code of Practice.)

Government response

Response: Agreed
Due date: July 2017

Implementation responsibility

Implementation: EPSDD

An overarching Code of Minor Public Works is being developed in place of a Code of Practice which guides maintenance works on Controlled Land that will instruct the Code of Potable Water Catchment Management and Code of Sustainable Land Management. This will combine and bring to completion recommendations 1, 3 and 4.

The Code of Minor Public Works will apply to all of the ACT, not just the Lower Cotter Catchment and is overdue for completion.

Status

Initiatives outstanding that require urgent attention

Observations

Auditor-General's recommendations 1, 3 and 4 each relate to the development and implementation of codes of practice.

In line with machinery of government changes, EPSDD now owns primary responsibility for the development and

implementation of the Code of Minor Public Works in consultation with other relevant agencies.

On review, EPSDD determined that one code of practice covering each of the three areas of concern expressed by the Auditor-General would be the most appropriate operational response.

The overarching code, referred to as the Code of Minor Public Works, will, when drafted, address a number of significant issues across the Territory, including incorporating a particular schedule for potable water catchment management, sustainable land management and maintenance practices. It will have practical application for all ACT Government reserves, not just the Lower Cotter Catchment. Once completed, the Code of Minor Public Works will be put up for Disallowance in the Legislative Assembly and subsequently implemented.

The Auditor-General stipulated that this work should be completed by July 2017. However, higher priority recommendations occupied the Implementation Coordination Group and the due date for recommendation 3 was not achieved. This has implications for other actions required by the recommendations.

The EPSDD Management Action Plan for implementing Auditor-General recommendations allows for executive management to request the EPSDD Audit Committee to consider an extension of timeframes. As per this process, the revised completion date for recommendation 3 was set to July 2018.

This date has now lapsed. There is no evidence of a further request for extension by executive management to the Audit Committee, rationale for the proposed extension, or consideration of the impact to business operations.

There is no discernible revised due date for the completion of recommendation 3 and it is therefore overdue. This report recommends that recommendation 3, which encompasses recommendations 1 and 4, be completed by June 2019.

AUDITOR-GENERAL'S RECOMMENDATION 4

The status of the draft Parks and Conservation Service, Code of Sustainable Land Management should be reviewed and either finalised or rescinded by the Territory and Municipal Services Directorate. If finalised, this should occur by October 2016.

Government response

Response: Agreed
Due date: July 2017

Implementation responsibility

Implementation: EPSDD

A Code of Sustainable Land Management is being developed. This will feed into the overarching Code of Minor Public Works which is under development and overdue for completion. Refer to implementation status of Auditor-General's recommendation 3 for more detail.

Status

Initiatives outstanding that require urgent attention



Examples of sediment control structures in Lower Cotter Catchment. Photo: Ian Falconer

AUDITOR-GENERAL’S RECOMMENDATION 5 – HIGH PRIORITY

New catchment management coordination and decision-making arrangements specifically for the Lower Cotter Catchment should be developed by the ACT Government and involve consultation with Icon Water, Territory and Municipal Services, Environment Protection Authority, Environment and Planning Directorate and Emergency Services Agency.

(The aim is to develop effective, streamlined coordination and decision-making arrangements at the high level, and to integrate these arrangements into the operational level. **An important consideration is that the decision-makers also have the authority to assign and commit the necessary resources to implement their decisions.**)

Government response

Response: Agreed
Due date: Immediate

Implementation responsibility

Implementation: EPSDD

The ‘Lower Cotter Catchment Implementation Coordination Group’, chaired by Director, Parks and Conservation Service, has been established and is scheduled to meet quarterly. This group was initially set up to facilitate a coordinated approach to implementation of the Auditor-General’s recommendations, however, continues to meet to discuss ongoing restoration works and land management operations that require collaboration across agencies. The chair reports to the Director’s-General Water Group.

Adherence to the Terms of Reference has not occurred in relation to regularity of the meeting and reporting to the Director’s-General Water Group.

This action relates to recommendation 4 of this report.

Status

Recommendation met but with opportunities for additional initiatives to be considered

Observations

In May 2015, the Director’s-General Water Group resolved to assume responsibility for all works relating to the management of the Lower Cotter Catchment.²

A multi-directorate taskforce was created to deliver on each of the Auditor-General’s recommendations, with a requirement to provide reports to the Director’s-General Water Group meetings.

The ‘Lower Cotter Catchment Implementation Coordination Group’, chaired by the Director, Parks and Conservation Service was established and required attendance of representatives from EPSDD, Icon Water, the Environment Protection Authority, and the Emergency Services Agency.

As outlined in the Implementation Coordination Group Terms of Reference,³ the primary function of the Coordination Group is to ensure a coordinated, whole of government approach is applied to the management of the Lower Cotter Catchment.

2 ACT Government, Director’s-General Water Group Minutes May 2015
3 Lower Cotter Catchment Implementation Coordination Group Terms of Reference

This was to be carried out in two separate phases as described below:

Phase 1

Oversight of implementation of the Auditor-General's recommendations, including:

- development of an implementation plan to address each of the Report's recommendations, including clarification of lead agencies and prioritisation of works,
- monitoring the progress of works against the Implementation Plan, and
- establishment of reporting protocols to the Director's-General Water Group.

Phase 2

Establish a key stakeholder liaison group for source water protection and land management within the Lower Cotter Catchment in the form of a consultative forum whereby agencies raise management issues for discussion.

With 18 management objectives and 67 management actions outlined in the reserve management plan, it is important that the Implementation Coordination Group remains in Phase 1 of the Terms of Reference. This will

support development of the implementation plan, regular risk reviews, and progress updates on management actions. The implementation plan progress should be reported to the Director's-General Water Group quarterly.

Records of meeting minutes from the 2017–18 Implementation Coordination Group and Director's-General Water Group indicate that the regularity of meetings and reporting requirements have not been met. Refer to recommendation 4 of this report.

This is problematic in that there is a disjuncture between the Director's-General Water Group decision making powers and the appropriate allocation and application of resources by the operational Implementation Coordination Group.

To ensure the effective implementation of current and future management actions in the Lower Cotter Catchment, it is critical that reporting protocols to the Director's-General Water Group are updated and adhered to. This is particularly important in relation to alignment in the budget cycles and appropriately allocating funding to reduce risk and ensure management activities are carried out.



Aerial view of Lower Cotter Reservoir. Source: Caitlin Roy



Road remediation and replanting on Old Black Boy Road. Source: Caitlin Roy

AUDITOR-GENERAL’S RECOMMENDATION 6

The Environment Protection Authority’s role as articulated in Section 64 of the *Water Resources Act 2007* should be implemented or reviewed.

(The Administrative Arrangements for water policy should align with section 64 of the *Water Resources Act 2007* or if existing arrangements are maintained in that water policy is in the Environment and Planning Directorate, the *Water Resources ACT 2007* should be amended.)

Government response

Response: Agreed
Due date: Immediate

Implementation responsibility

Implementation: EPSDD

The Environment Protection Authority’s role pursuant to section 64 was reviewed early in 2016 and consequently it was determined that certain functions related to catchment management and water policy would be appropriately delegated to the Executive Director, Environment Division, EPSDD. This was executed via an instrument on 23 May 2016. (See Notifiable Instrument NI2016–249 made under the *Water Resources Act 2007*, s65).

In October 2018 these delegations were revoked.

Status

Recommendation met but with opportunities for additional initiatives to be considered

Observations

EPSDD commenced a review of the *Water Resources Act 2007* to determine if amendments were required to reflect the current administrative and policy arrangements for water resource management as detailed under Section 64 of the Act.

Environment Protection Policy, EPSDD undertook an initial review of the Environment Protection Authority’s role under the Act and formed a working group with

EPSDD representatives from Catchment Management and Water Policy, the Conservator of Flora and Fauna and Access Canberra.

The working group determined that the Environment Protection Authority should have the following functions under the Act:

- (a) keep the state and condition of the water resources of the Territory under review,
- (b) coordinate policies in relation to water resource management,
- (c) regulate the allocation of water from waterways,
- (d) compile and maintain up-to-date information about the water resources of the Territory,
- (e) promote the importance, and encourage the efficient use of water resources,
- (f) foster public education about the management of water resources,
- (g) implement national water resource measures made under national scheme laws or intergovernmental agreements relating to water resource management,
- (h) confer, and exchange information, with any entity having functions corresponding to those of the authority under a law of the Commonwealth, a State or another Territory relating to water resource management, and
- (i) undertake any other functions given to the authority under this Act.

Agreement had been reached with the Environment Protection Authority to delegate policy functions under the Act to the Executive Director, Environment Division, EPSDD.

The Notifiable Instrument (NI2016–249) delegating sections 64(1)(a), (b), (d), (e), (f), (g) and (h) of the Act to the Executive Director, Environment Division was notified 23 May 2016.

On 10 October 2018, these delegations were revoked. This affected the implementation status of recommendation 6. Additional attention should be considered before recommendation 6 can be formally closed.

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AUDITOR-GENERAL'S RECOMMENDATION 7 – HIGH PRIORITY

A cross-agency risk management process and plan for the management of the Lower Cotter Catchment in reference to the land managed as a drinking water catchment should be developed by the Territory and Municipal Services Directorate, in consultation with key stakeholders, in particular Icon Water, Emergency Services Agency and the Environment and Planning Directorate.

(Territory and Municipal Services should therefore take carriage of the risk process and plan which should be reviewed every three years or sooner if the risk profile merits review.)

Government response

Response: Agreed

Due date: June 2016

Implementation responsibility

Implementation: EPSDD

A Lower Cotter Catchment Risk Assessment and Risk Treatment Plan was completed in May 2016 and endorsed by the Director's-General Water Group at its June 2016 meeting.

Since this time, there has been no review of the Risk Treatment Plan. Only certain aspects of the plan have been incorporated into the Reserve Management Plan 2018, and some of these appear with different ratings which has not been explained.

This action relates to recommendation 3 of this report.

Status

Recommendation met but with opportunities for additional initiatives to be considered

Observations

In line with machinery of government changes, Parks and Conservation Service, rather than TAMS, owns primary responsibility for the development, implementation and review of the Risk Treatment Plan.⁴

In June 2016 the Director's-General Water Group endorsed the Risk Treatment Plan for the Lower Cotter Catchment in accordance with recommendation 7 of the

Auditor-General's Report.⁵ The Risk Treatment Plan, carried out by Echelon Australia, considered 58 risks under a range of categories, including:

- fire management,
- native animals,
- native vegetation,
- pests and disease,
- access,
- recreation, and
- water management.

The Risk Treatment Plan identified 27 risks with 26 considered 'high risk' and one considered 'moderate risk'. The plan outlined agency ownership, risk treatment strategies and associated timelines.

The Risk Treatment Plan has been incorporated in part into the Reserve Management Plan 2018. However only 13 of the 27 identified risks have been included. 12 of the 13 risks are considered 'high risk' and one is considered 'extreme risk' – that 'fire during elevated fire danger conditions will result in significant reduction in water quantity and quality.'⁶

Since completion of the Risk Treatment Plan in June 2016, and incorporation in part into the Reserve Management Plan 2018, there has been no evidence of review or update to the Risk Treatment Plan by either the Director's-General Water Group or the Implementation Coordination Group. No rationale has been provided for the determination of what constitutes high risk categories in the reserve management plan, or, the change of risk rating from high to extreme.

Given the high degree of risk associated with managing fire to protect water supply, and in order to comply with the ACT Insurance Agency risk management processes, a regular and collaborative process for reviewing the Risk Treatment Plan is imperative. This should be carried out by the Implementation Coordination Group with further endorsement from the Director's-General Water Group.

In order to comply with the Auditor-General's recommendation this must occur before June 2019.

⁴ Echelon Australia, Lower Cotter Catchment Risk Treatment Plan 2016

⁵ ACT Government, Director's-General Water Group Meeting Minutes June 2016

⁶ ACT Government, Lower Cotter Catchment Reserve Management Plan 2018

AUDITOR-GENERAL’S RECOMMENDATION 8

The Plan of Management for the Lower Cotter Catchment should be finalised, by the Territory and Municipal Services Directorate.

(Community consultation for the Plan of Management should be based on the knowledge that the key management objectives for the Lower Cotter Catchment have been decided and are contained in the *Planning and Development Act 2007* and the *Territory Plan 2008*.)

Government response

Response: Agreed
Due date: July 2017

Implementation responsibility

Implementation: EPSDD

The Draft Lower Cotter Catchment Reserve Management Plan was released for public comment by EPSDD in January 2017. The final Plan was tabled by the Minister for Environment in the Legislative Assembly in February 2018.

As yet, there is no implementation plan for the 67 management actions identified in the plan.

Status

Recommendation met but with opportunities for additional initiatives to be considered

Observations

In line with machinery of government changes, EPSDD owns primary responsibility for the development and implementation of the Lower Cotter Catchment Reserve Management Plan 2018.

Development of the plan took longer than expected due to the volume of public submissions received as well as competing priorities in implementing the Auditor-General’s recommendations.

The final plan, Lower Cotter Catchment Reserve Management Plan 2018, was tabled by the Minister for Environment in the Legislative Assembly on 20 February 2018.

Management actions are identified in each chapter of the plan and are consolidated in a table of actions. There are 67 management actions in total. The table includes priorities and responsibilities for implementing the actions, and will form the basis of a separate implementation plan to be developed by the land manager.

Overview of implementation priorities for management actions:

The implementation plan will include evaluation methods and key indicators to measure the progress and success of implementation. A report on implementation will be provided to the Minister five years from the tabling date of the Reserve Management Plan 2018, being 20 February 2023.

To date, there is no discernible evidence of the development of an implementation plan. Given the significant number of high and medium priority management actions and impending due dates, it is critical that the implementation plan be developed and actioned as a matter of urgency. Refer to recommendation 2 of this report.

PRIORITY RATING	TIMELINE FOR IMPLEMENTATION	NUMBER OF ACTIONS	DUE DATE
High	Within three years of the publication of The Plan	32 of 67	February 2021
Medium	Within five years of the publication of The Plan	32 of 67	February 2023
Low	Within the life of The Plan	3 of 67	February 2028
*Ongoing	*Ongoing throughout the life of the plan	55 of 67	February 2028



Aerial view Lower Cotter Catchment road network, 2007. Source: Mark Butz



Aerial view Lower Cotter Catchment road network, 2018. Source: Caitlin Roy

AUDITOR-GENERAL'S RECOMMENDATION 9

An action plan for the removal of the regrowth and unmanaged remnant pine forests in, and adjacent to, the Lower Cotter Catchment should be developed and implemented by the Territory and Municipal Services Directorate. In the development of the plan and in implementing it consultation should occur with the Emergency Services Agency, the Environment and Planning Directorate, and Icon Water.

Government response

Response: Agreed
Action: EPSDD
Due date: 2019

Implementation responsibility

Implementation: EPSDD

Work has been completed on the Blue Range Rehabilitation Plan, which sets out a three year plan of action to manage pine regrowth in the Blue Range area of the Lower Cotter Catchment. Implementation is scheduled over the next three years with 68 hectares of pine regrowth within the Lower Cotter Catchment to be removed in 2016–17. EPSDD will lead the delivery of works on the ground and report regularly to the Lower Cotter Catchment Implementation Coordination Group.

Timeline for removal of pines:

2016–17: 68.7 hectares

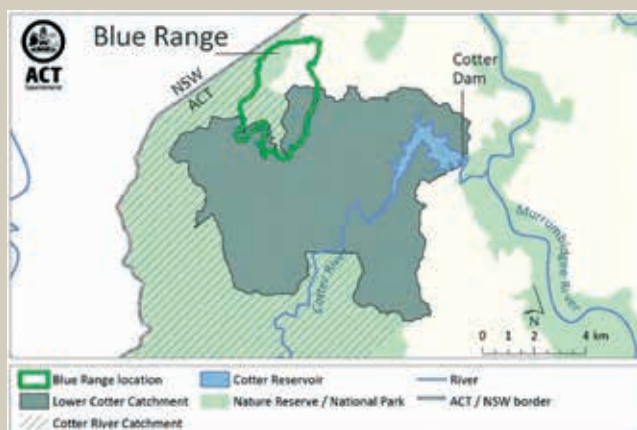
2017–18: 87.1 hectares

2018–19: 70.5 hectares

Status

Recommendation met but with opportunities for additional initiatives to be considered

Observations



Source: Lower Cotter Catchment Reserve Management Plan 2018

In line with machinery of government changes, EPSDD owns primary responsibility for the development and implementation of the action plan for the removal of the regrowth and unmanaged remnant pine forests in and adjacent to the Lower Cotter Catchment.

The Fire, Forests and Roads section within Parks and Conservation Service, EPSDD developed an action plan titled the Blue Range Rehabilitation Plan 2015–18⁷ which identifies priorities and objectives to meet recommendation 9 of the Auditor-General's Report.

Blue Range was identified as a critical remediation site for the following reasons:

- density of pine regrowth up to 80,000–100,000 pines per hectare,
- likelihood of uncontrolled fire entering the catchment through the north-western border,
- proximity to Namadgi National Park, and
- steep gradient, high clay content and highly erodible soils presenting a risk to water quality through direct connectivity to Condor Creek, one of the major tributaries of the Cotter River.

Due to the size and density of pines in these areas and steep gradient of the land, controlled burns were not considered feasible and a range of alternative methods were trialled. In combination with sediment monitoring, the trial resolved that physical disturbance by excavation would be most suited to the steep and undulating terrain while reducing risk to catchment values.

Using this method, high densities of pines were felled and mulched, leaving behind scattered pockets of native vegetation. It was anticipated that this treatment approach could mobilise soil, create gullying and increase runoff, particularly after high rainfall, however this did not occur.

Sediment traps in drainage lines at the base of Blue Range indicated minimal run-off, largely attributed to the heavy mulch left behind from the excavator head (often referred to as a tritter). This mulch not only improved soil stability, but assisted with water retention and provided a thick protective layer encouraging the nearby native seedbank to recolonise.

Two years into the plan, over 150 hectares of pine wildling regrowth has been removed with an additional 70.5 hectares to be completed in 2018–19 financial year. A range of techniques to reduce the risk and impact of unplanned fire have been successfully applied.

Completion of the plan in 2019 will meet the requirements of recommendation 9 of the Auditor-General's Report. However ongoing funding and management will be required to maintain this high risk area.

7 ACT Government, Parks and Conservation Service Blue Range Rehabilitation Plan 2015-2018

“The tritter can be used as a scalpel or a sword, mulching small plants while working around established trees that benefit fire control by reducing heat and providing shade.”

Fire, Forests and Roads, Parks and Conservation Service.

METHODS OF PINE WILDLING MANAGEMENT



Aerial view of Blue Range following pine wildling removal trial 2017. Source: Ian Falconer



Hand felled pine wildlings 1 week post removal in a particularly steep area of Blue Range. Source: Ian Falconer



Blue Range from Apple Tree Corner – 6 months post pine wildling removal trial in foreground, 1 week post pine wildling removal trial on opposite ridge. Source: Ian Falconer

AUDITOR-GENERAL'S RECOMMENDATION 10

The road and fire trail network in the Lower Cotter Catchment should be reviewed and a road network improvement plan should be developed by Territory and Municipal Services in consultation with Emergency Services Agency, Icon Water and the Environment and Planning Directorate.

(The review should define the minimum road and fire trail network that balances the goal of access for firefighting with the goal of minimising roads and fire trails so as to minimise erosion and sediment movement into the reservoir; and examine gates and other control structures that effectively restrict or control public access but allow access for firefighting and service needs.)

Government response

Response: Agreed

Due date: July 2016

Implementation responsibility

Implementation: EPSDD

The Lower Cotter Catchment Implementation Coordination Group has approved the revised Lower Cotter Catchment Road Network Improvement Plan. The Plan, which informs the extent and classification of the road network in the Lower Cotter Catchment was informed by a road matrix which evaluated each road on five criteria including: safety, quality, soil stability, fire operations and land management or public recreation. The plan will be reviewed on an ongoing basis to meet land management needs.

Status

Recommendation met but with opportunities for additional initiatives to be considered

Observations from this office

In line with machinery of government changes, EPSDD now owns primary responsibility for the development and review of the Road Network Improvement Plan.

The Lower Cotter Catchment Road Network Plan has been developed by the Lower Cotter Catchment Road and Fire Trail Working Group, comprising the following stakeholders:

- Emergency Services Agency: responsible for fire suppression.
- Fire, Forests and Roads section of ACT Parks and Conservation Service: responsible for implementation of the Bushfire Operations Plan and management of the overall PCS road network and infrastructure.

- Murrumbidgee River Corridor section of the Parks and Conservation Service (land manager: responsible for land management including erosion control, weed management, and visitor access).
- Icon Water: responsible for the delivery of safe drinking water and associated infrastructure.

The Road Network Improvement Plan relies on a matrix which evaluates each section of road against key criteria including:

- fire suppression and emergency response,
- hazard reduction,
- land management including erosion and vegetation, and
- recreational access.

The plan prioritises roads with strategic fire-fighting and land management importance as well as those with direct connectivity to waterways. A score is derived using the matrix which indicates whether a road will be maintained, made dormant or 'extinct', if rendered obsolete.

On the one hand there is a need to maintain roads for access to the catchment for both day to day management and for response to fire. However, equally, concentrated drainage discharged off roads is a major cause of gullying, and opens up opportunities for recreational use and misuse which further compounds erosion and associated run-off.

Roads that minimise the concentration of flows in unstable soils will reduce the probability of both gully initiation and the acceleration of existing gullies. Such gullies are considered a primary source of both sedimentation in waterways and the mobilisation of suspended sediments into the Cotter Reservoir.⁸

Since 2003 the main focus of land management in the Lower Cotter Catchment has switched from forestry to water catchment management. The intensity of land management activities, particularly erosion control and weed management, still require a high level of access. As some of these activities are progressed, more roads may be considered for closure.

Ideally for water quality, the road network should be reduced to the minimum, with all other roads made extinct and rehabilitated.

Currently, roads appear to have been decommissioned rather than rehabilitated, resulting in unauthorised access and limited revegetation. Revegetation and soil stabilisation will require comprehensive ripping, de-compaction, reshaping, fertilisation, and seeding.

8 Landloch Reports 2006, 2008, 2015

The Road Network Improvement Plan recommends that the road and access network be formally reviewed on a five year basis, consistent with the statutory review of the reserve management plan.

The Road Network Improvement Plan was finalised on 30 March 2017. However following the proposed five yearly recommendation, the review would not take place until February 2023.

Given the intricate balance of the road network contributing to fire management, land management and recreational access, it is recommended that an annual review of the road network matrix be undertaken by the Lower Cotter Catchment Road and Fire Trail Working Group and reported to the Implementation Coordination Group.



Condor Creek road culvert full of sediment. Source: Caitlin Roy

AUDITOR-GENERAL’S RECOMMENDATION 11 – HIGH PRIORITY

The effectiveness of sediment control structures in the Lower Cotter Catchment should be assessed to identify damaged and poorly functioning structures and pondage, and an action plan developed for implementing repairs by Territory and Municipal Services in collaboration with Icon Water.

Government response

Response: Agreed
Due date: 2016

Implementation responsibility and status

Implementation: EPSDD

In July 2015 Landloch was commissioned to prepare a report on the state of sediment control structures within the Lower Cotter Catchment and recommendations for remediation. The report reviewed all known (38) sediment control structures in the catchment.

A total of ten structures (eight gabion check dams and two rock check dams) were prioritised for remedial work and all these works were successfully completed in 2016. Ongoing resourcing is required to maintain the completed works and commence new remediation works.

Status

Recommendation met but with opportunities for additional initiatives to be considered

Observations

In line with machinery of government changes, Parks and Conservation Service, rather than TAMS, now owns primary responsibility for the development and implementation of an action plan for the remediation of sediment control structures.

Landloch was engaged to carry out a number of site inspections (2006, 2008 and 2015)⁹ focussing on widespread gully erosion resulting from the 2003 fires, and the subsequent establishment and management of sediment control structures.

Focus is now on expanding beyond the existing structures into point source remediation to prevent erosion at the source in high risk areas such as Pierces Creek. This area has highly erodible soils and a large proportion of roading network. So far, 7 kilometres of gullies in the Pierces Creek area have been mapped and prioritised for remediation. The highest priority gullies for remediation are those with direct connectivity to waterways.

Turbidity monitoring is the most accurate way to identify mobilisation of sediment from roads into waterways. However, the current absence of turbidity monitoring in creeks and streams is a major limitation.

Without future budget investments in monitoring and resourcing it will not be possible to continue the current level of erosion control maintenance as well as additional point source remediation for high risk areas.

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Large erosion gullies in Pierces Creek sub-catchment. Source: Caitlin Roy

9 Landloch Reports 2006, 2008, 2015

EROSION AND SEDIMENT BUDGETS

The Reserve Management Plan 2018 identifies erosion as a primary risk to water quality, through increased turbidity coming from actively eroding sites. A second erosion risk is the smothering of aquatic habitat by sediment coming from concentrated erosion sites such as roads and gullies.

Research and monitoring since 2003 has identified that turbidity in the Lower Cotter Catchment increased dramatically after the bushfires and continues to be at elevated levels while turbidity in surrounding burnt areas, such as the Upper Cotter Catchment, has since recovered from the fire.¹⁰

There are several features of the Lower Cotter Catchment that make it more susceptible to ongoing erosion. Combined with its highly erodible soils, the salvage logging operations of the burnt pine plantation further exposed soil to erosion. Log rows from these operations diverted and concentrated overland flow in places and erosion gullies have formed, several of which are associated with roads and plantation work. The relatively high density of access roads, necessary for fire and land management, contribute to the erosion sediment.

There are a range of sources of sediment: hillslopes, gullies and roads. It is not clear from past work which sources present the greatest problem.

Not all erosion contributes to in-stream turbidity and bedload. The majority of eroded sediment is deposited before reaching streams. It is deposited in flatter areas, at the base of gullies or road culverts, or in wetlands.

There is a lot of spatial variation in erosion rates with a few places of high erosion rates, and a lot of the landscape experiencing lower erosion rates.

When the two factors above are put together it is typically found that some 80 per cent or more of the sediment problem comes from less than 20 per cent of the catchment area.

To effectively manage erosion in the catchment, high erosion sites must be identified and updated regularly.

The above concepts could be analysed by constructing a sediment budget, which identifies the spatial patterns of erosion and deposition across a catchment. This has not yet been undertaken for the Lower Cotter Catchment.

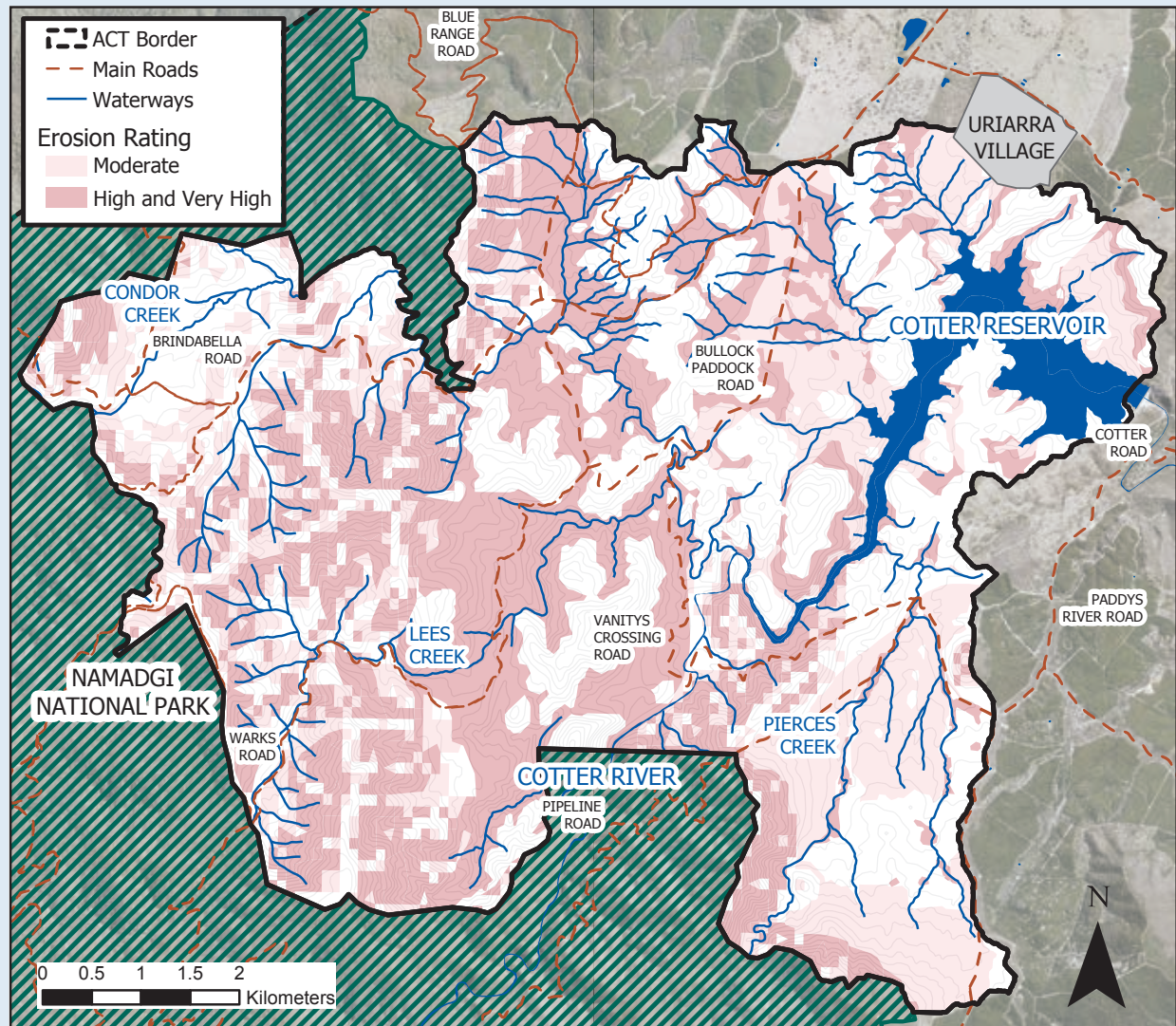
A sediment budget will show which erosion processes are now the most important and which locations contribute the most sediment. It can identify the sources of turbidity and areas of concern for bedload smothering.

Monitoring sediment loads from each sub-catchment will help identify sources of sediment. At eroding sites, repeated surveys can be used to determine if erosion is continuing or has stabilised. The same can be done at sites of deposition, especially sediment traps, to determine if they are continuing to work as effective stores of sediment.

While there has been quite a bit of work investigating erosion in the Lower Cotter Catchment, a sediment budget has not been constructed. A sediment budget could lead to more effective management of erosion, turbidity and aquatic habitat quality and better evaluation of management to date.

10 ACT Auditor-General's Report, Restoration of the Lower Cotter Catchment Report No. 3/2015

Erosion Hazard in the Lower Cotter Catchment 2018



68
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Serena Farrelly and Jack Wales. Office of the Commissioner for Sustainability and the Environment, November 2018

EFFECTIVE MANAGEMENT OF BROAD SCALE EROSION REMEDIATION WORKS

Founding Director of Landloch, Dr Rob Loch B.Agr.Sc., B.A., Ph.D, CPSS3



Lower Cotter Catchment overview

The Lower Cotter Catchment occupies around 6000 hectares of Australian Capital Territory Controlled Land, and is a significant part of Canberra's water catchment.¹¹ Following catastrophic bushfires in 2003, soil erosion (largely gullying) has caused declines in water quality that are expensive to treat. Erosion continues to be a problem for water quality.¹²

Who is doing catchment and gully repair well?

A key component of successful land management is reliable access to funding to undertake work. Erratic or episodic funding will not achieve effective erosion control.

Sydney Catchment Authority

Sydney Catchment Authority has implemented a framework with public access restrictions, water catchment declaration, revegetation and monitoring. A Catchment Decision Support System which targets a range of pollutants including sediment and turbidity has been implemented.¹³

Sydney Catchment Authority have a module for mapping gully erosion using remote sensing at scales much larger than Lower Cotter Catchment. Gully erosion in the Sydney Catchment Authority catchments was a major issue in the mid-1850s and mid 1900s but stabilisation through the late 1900s Catchment Protection Scheme has reduced outputs.

The Sydney Catchment Authority and Water NSW¹⁴ prepare annual Catchment Protection Work Programs. This includes targeting erosion in specific sub-catchments using funding inducements to landholders for on ground works. Landholders can undertake the work themselves or use contractors.

South East Queensland (SEQ) Catchments

Major on ground works were implemented around Brisbane following major flood and gully erosion in 2010–11. Funding was controlled by SEQ Catchments (now Healthy Land and Water) with works undertaken by landholders or skilled contractors. On ground works were audited to ensure they had been undertaken and to learn how to improve implementation. Youth employment schemes such as the Green Army were used for some works and unemployed people were able to gain industry certification of skills.

Catchment groups in Queensland have been successful at treating erosion where regular funding is secured, erosion control works are monitored and works are staged to address areas of highest risk first. Landholders receive funding to repair gullies, revegetate areas or undertake other contracted works. Outcomes are audited and a reverse action system is used to gain the greatest value of works (Condamine Alliance and Queensland Murray Basin Committee both run similar systems).

A similar outcome could be sought in the Lower Cotter Catchment by making erosion control funding competitive and based on measured outcomes.

Concluding comments

Erosion is controlled well by organisations that:

- prioritise areas of highest risk based on science,
- commit regular funding to implement on ground works,
- maintain those works until stabilised, and
- monitor implementation of controls and adapt their management.

¹¹ ACT Government, Lower Cotter Catchment Strategic Management Plan 2007

¹² Landloch 2015. Inspection of Gullying and other Land Management Issues, Lower Cotter Catchment; Report prepared for the ACT Parks and Conservation Service.

¹³ Sydney Catchment Authority 2009 Prioritising Catchment Actions – The Catchment Decision Support Systems 2009-2010

¹⁴ Water NSW 2018 Website accessed 7 September 2018 https://www.watarnsw.com.au/__data/assets/pdf_file/0007/133927/WaterNSW-Catchment-Protection-Work-Program-2017-18.pdf

AUDITOR-GENERAL'S RECOMMENDATION 12

The Commissioner for Sustainability and the Environment should evaluate the restoration of the Lower Cotter Catchment against the Management Goals contained in the Strategic Management Plan, and report to the Minister for the Environment on priorities to be identified for the next decade, by December 2017.

(This aligns with the requirement in the Strategic Management Plan for it to be evaluated, Section 1.1)

Government response

Response: Agreed

Due date: December 2018

Implementation responsibility

Implementation: OCSE

Date extended to December 2018 approved by Minister for the Environment to allow completion of Reserve Management Plan 2018. Evaluation report provided to the Minister for the Environment in December 2018.

Status

Recommendation met but with opportunities for additional initiatives to be considered

Observations

In September 2016, Minister Corbell wrote to the Commissioner directing the preparation of a special report under Sections 12 and 21 of the *Commissioner for Sustainability and the Environment Act 1993* in response to recommendation 12 of the Auditor-General's Report.

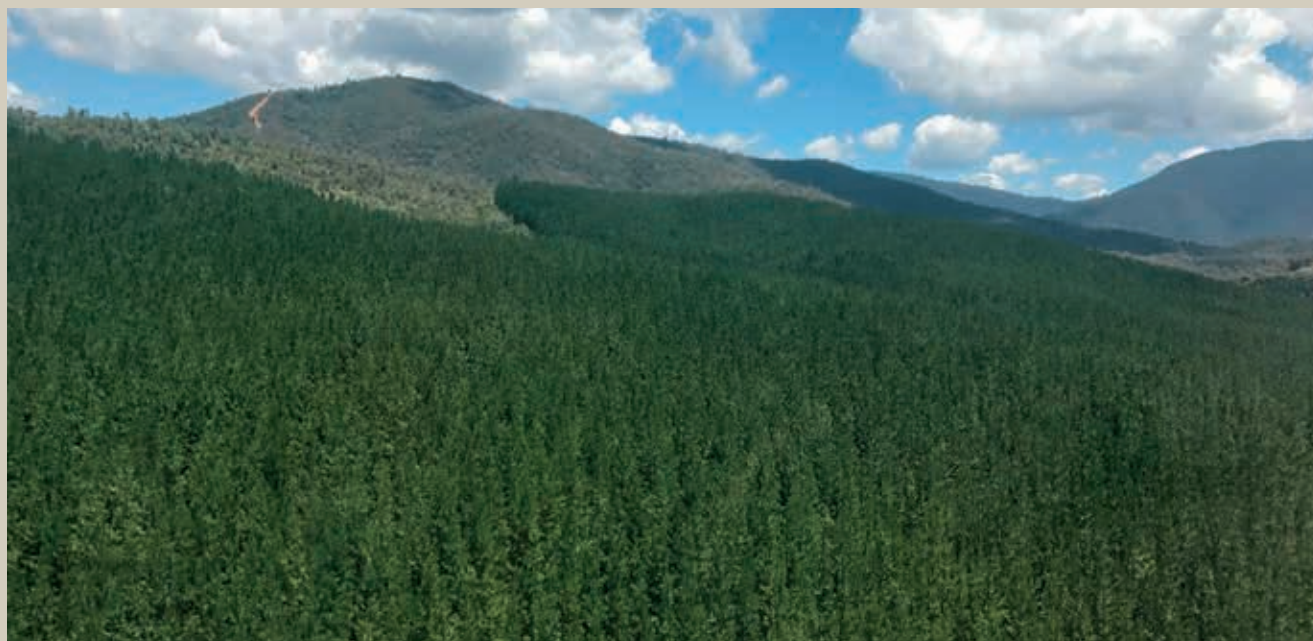
At this time, the forthcoming Lower Cotter Catchment Reserve Management Plan was under development, limiting the ability to evaluate the effectiveness of management goals contained in the plan. To allow adequate time following the completion of the plan to conduct an effective evaluation, the Minister granted an extension to December 2018.

During the community consultation period for the reserve management plan, the Commissioner provided a submission with eight recommendations. These were primarily in relation to monitoring, evaluation, and demonstrating accountability for the implementation of management actions.

The final reserve management plan was tabled in February 2018, leaving a six month period to evaluate the effectiveness of management actions. Therefore, the approach to this report was to primarily review audit recommendations and develop a robust framework to monitor and evaluate water and ecological values over time.

This report, titled *The Heroic and the Dammed – Lower Cotter Catchment Restoration Evaluation* – was provided to the Minister in December 2018, in line with the extended due date. Recommendations from this report will require additional funding and ongoing attention throughout the life of the Reserve Management Plan 2018.

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71



Aerial view of commercial pine plantation, Lower Cotter Catchment. Source: Caitlin Roy

4.3 Standing Committee on Public Accounts Review of Auditor-General's Report Recommendations

4.3.1 OVERVIEW

The Auditor-General's Report No. 3/2015 was presented to the Legislative Assembly in May 2015.

In accordance with the resolution of appointment of the Standing Committee on Public Accounts, the Report was referred to the Committee for examination.¹⁵

The Committee examined the Report and additional public submissions, giving consideration to the implementation of the Strategic Management Plan 2007 and development of the then forthcoming Reserve Management Plan 2018.

The Committee report (PAC Report) was tabled in July 2016 with seven recommendations.

The ACT Government noted, agreed, or agreed in part to all of the recommendations.

Traffic light indicators have been used to reflect the implementation status of Standing Committee on Public Accounts recommendations as they relate to the Auditor-General's Report or Reserve Management Plan 2018 as at 31 October 2018.

INDICATOR	INDICATION
Green	Recommendation met, no ongoing attention required
Blue	Recommendation met but with opportunities for additional initiatives to be considered
Amber	Initiatives in progress that require ongoing attention
Red	Initiatives outstanding that require urgent attention

¹⁵ Standing Committee on Public Accounts Review of Auditor-General's Report No.3 of 2015: Restoration of the Lower Cotter Catchment Report 31/2016.

4.3.2 IMPLEMENTATION STATUS OF PAC REPORT RECOMMENDATIONS – SUMMARY FINDINGS

Recommendation 1 of the PAC Report relating to a sustainable funding model is addressed in the Government's Response, noting that the ACT Government prefers to fund the ongoing management of the Lower Cotter Catchment using an adaptive management model.

This means that operational stakeholders make annual budget bids for both operational and strategic priorities. Budget bids are put forward to support new initiatives and priorities. These are considered for funding by Budget Cabinet on their merit, along with the Whole of Government perspective Treasury is able to bring.

While this is the accepted process for securing funding for the management of Controlled Land in the ACT, it exposes the potential for localised management actions to be overlooked in the broader context of the ACT.

This is a time consuming, and often unsuccessful process, that diverts the valuable time of land managers away from their core operational responsibilities, thereby increasing risk to water quality and ecological values.

Since 2003 nearly \$10 million has been contributed by ACT Government to carry out remediation works in the Lower Cotter Catchment to ensure a steady supply of quality drinking water for Canberra and the surrounding region. However, it is critical that adequate recurrent funding, increased from the current level, is provided to continue long-term effective management of the catchment. A mechanism to address recurrent funding is proposed in the case study on page 74.

Recommendation 2 of the PAC Report related to improving transparency with regard to budget inflows and outflows for the management of the Lower Cotter Catchment and how these flows are apportioned across the two primary stakeholders; ACT Government and Icon Water.

While the Government committed to this, there is no discernible evidence that this has occurred, and additional attention is required.

Recommendations 3 and 4 of the PAC Report have been completed through the legislative process.

Recommendations 5, 6 and 7 of the PAC Report have been addressed in part through the Reserve Management Plan 2018, though these require additional attention and ongoing resourcing to uphold the intent of the PAC Report recommendations.

Management actions in the reserve management plan addressing the need for a communication and education strategy targeting recreational access and community engagement are ambiguous and do not meet the intent of the PAC Report recommendations.

Commitments in the Government's Response to the PAC Report recommendations relating specifically to updating public content to raise awareness of management activities, recreational access controls, and volunteer contributions to restoration that promote a sense of community custodianship, have not occurred.

Significant attention and additional funding is required to address these recommendations, consolidating them with the Auditor-General's recommendations and the Reserve Management Plan 2018.

A COMMUNITY ENGAGEMENT STRATEGY IN PICTURES



*Examples of Lower Cotter Catchment public signage.
Source: Kate Auty*

72
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73

TRACKING THE WATER ABSTRACTION CHARGE (WAC)

What is the WAC?

The Water Abstraction Charge (WAC) is a charge collected from those licensed to take water in the Territory. The WAC is imposed by the Water Resources (Fees) Determination 2018, made under Section 107 of the *Water Resources Act 2007*.

The WAC applies to each kilolitre of water abstracted and is separately determined for two separate categories, being:

1. the urban water supply network, and
2. source water or groundwater.

For potable water (that taken for the urban water supply network), the WAC is collected from consumers by Icon Water through water prices, and remitted directly to the ACT Government. For source water or groundwater, the WAC is paid directly by licence holders to the ACT Government.

How is the WAC set and regulated?

The Minister for the Environment and Sustainable Development sets the WAC rate under Section 107 of the *Water Resources Act 2007*. This is currently set at a rate of \$0.595 per kilolitre (2018–19) for urban water usage, and \$0.287 per kilolitre for source water or groundwater. The annual remittance to the ACT Government in relation to potable water use is estimated using both the total water released and the charge rate in each year.

Revenue received from the WAC is not hypothecated.

The objective of the WAC is to reflect the true value of water, and is not solely a reflection of the direct cost incurred by Government. The calculation of the WAC comprises the following components:

1. Urban and non-urban water supply costs: this includes government expenditure on activities such as catchment management, environmental protection of ACT streams and lakes, water policy and administration.
2. Scarcity of water: this is the value associated with the consumptive use of water in the ACT preventing its alternative use for other economically valuable purposes such as irrigation.
3. Environmental value: this relates to costs of environmental flows, including the effect of storing water in dams on downstream flows, collecting and analysing data on the levels of extractions and the water quality in ACT lakes and streams.¹⁶

The Independent Competition and Regulatory Commission (ICRC)¹⁷ regulates the price of potable water in the Territory, and reports on water utility revenue and operating expenditure. As part of the process for determining water prices in the Territory, the ICRC determines the estimated amount of WAC revenue that will be collected by Icon Water during a regulatory period, based upon forecast potable water use. This occurs under *Disallowable Instrument DI2003–333 Utilities (Water Abstraction Charge) Ministerial Direction 2003 (No 1)*,¹⁸ which directs the ICRC to pass through the WAC.

The WAC is also reported by ACT Government to the Australian Competition and Consumer Commission (ACCC)¹⁹ annually.

Estimates outlined in the ACT Government 2017–2018 Budget paper No. 3²⁰ indicate that the WAC is worth more than \$92 million in revenue to the ACT Government over the next three years.

Tracking the WAC

The ACCC Water Monitoring Report 2016–17,²¹ purports that the majority of revenue raised for water planning and management activities in the ACT is sourced from the WAC.

However, recent exercises to reconcile the amount collected in WAC revenue, \$32.279 million reported in Budget Paper No. 3 2017–18,²² with the water related expenditure listed above, highlights the amount collected significantly exceeds the amount spent.

With recent increases in catchment management assets, future programs outlined in the ACT Water Strategy 2014–44,²³ and imminent drought and climate change conditions, there is an alarming disjuncture between WAC revenue and the amount spent on water planning and management.

This report recommends that in the absence of any consistent alternative means, discrete additional annual funding be provided for catchment management, environment protection and water policy and planning, at least for the life of the current reserve management plan. Annual WAC revenue would provide a viable and ongoing source for this.

¹⁶ https://www.environment.act.gov.au/water/water_planning_and_management/act_water_abstraction_charge accessed 19 June 2018

¹⁷ Independent Competition and Regulation Commission Final report Regulated water and sewerage services prices 2018–23

¹⁸ *Disallowable Instrument DI2003–333 Utilities (Water Abstraction Charge) Ministerial Direction 2003 (No 1)*

¹⁹ Australian Competition and Consumer Commission

²⁰ ACT Government 2017–2018 Budget paper No. 3

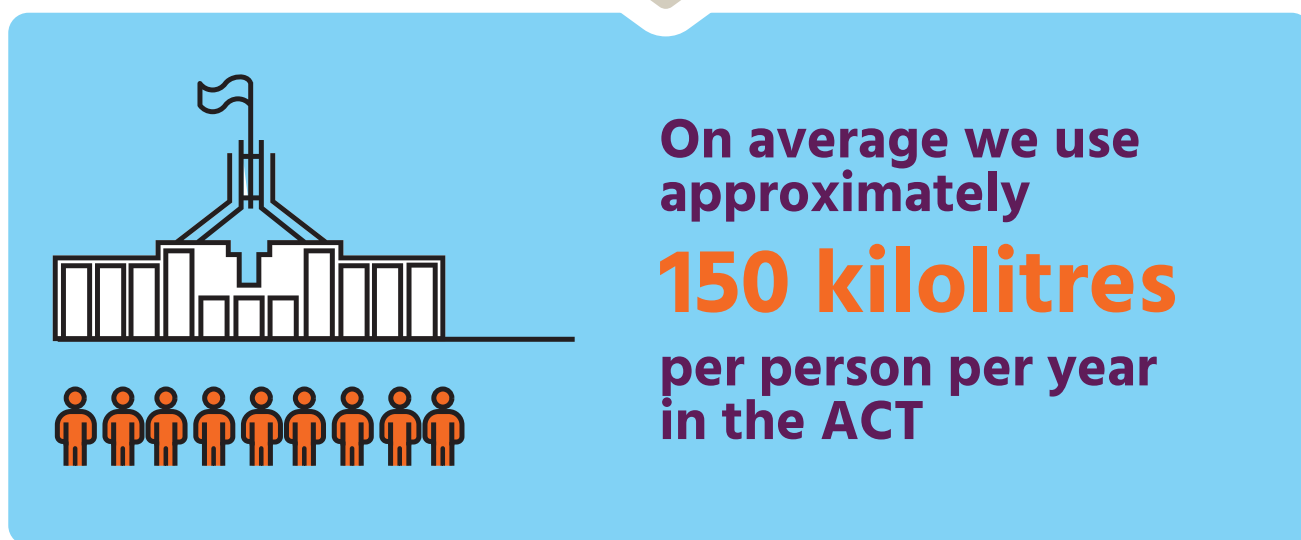
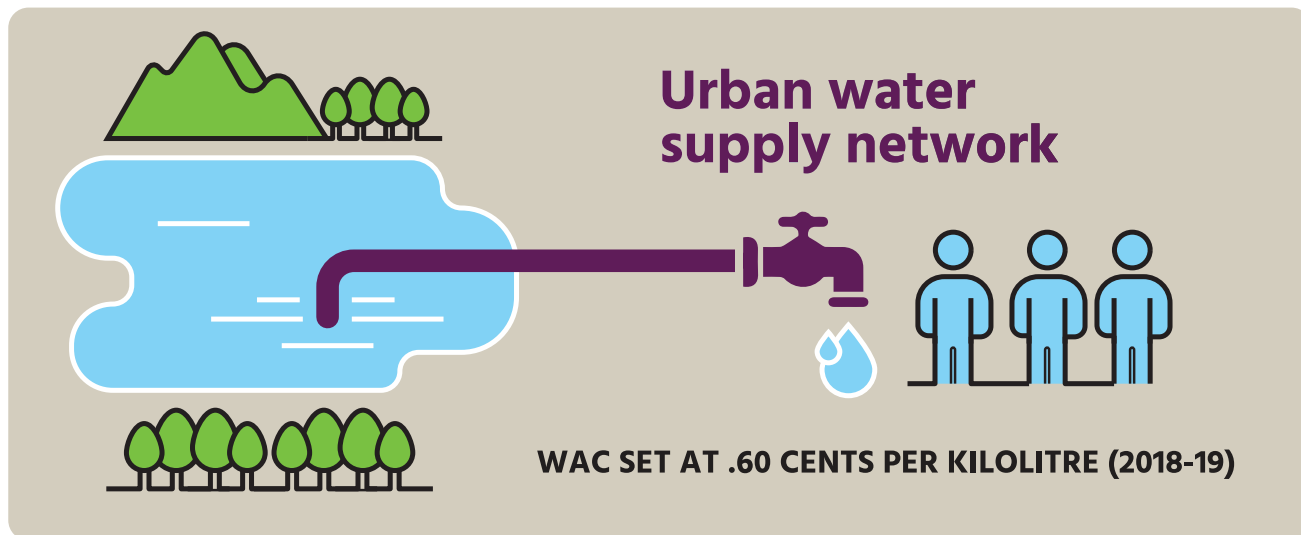
²¹ ACCC Water Monitoring Report 2016–17.pdf accessed 19 June 2018

²² ACT Government 2017–2018 Budget paper No. 3

²³ ACT Government 2014. ACT Water Strategy 2014–44: Striking the Balance

WATER ABSTRACTION CHARGE (WAC)

Where does it go?



4.3.3 IMPLEMENTATION STATUS OF PAC REPORT RECOMMENDATIONS

PAC REPORT RECOMMENDATION 1

The Committee recommends that the ACT Government implement a sustainable funding model for management of the Lower Cotter Catchment through the Plan of Management for the Lower Cotter Catchment.

Government response

Response: Noted

Action: N/A

Due date: N/A

Status

Recommendation met but with opportunities for additional initiatives to be considered

Plans of Management focus on providing the management framework within which protected areas are to be managed. They provide policy direction on appropriate management strategies that may be adopted by the land management agency. Plans of management have traditionally not attempted to commit ACT Government funding, with the land manager instead pursuing funding initiatives through participation in annual Treasury led budget funding processes.

Plans of Management typically have a currency period of ten years after which time they are reviewed. Decisions on funding are best made in a holistic context and in response to prioritised needs, which of course may change over time.

The Government prefers to fund the management of the Lower Cotter Catchment using an adaptive management model.

That is to say, as the land manager applies and learns from the applications of on ground works and strategies, budget bids are put forward to support new initiatives and priorities. These are considered for funding by Budget Cabinet on their merits and with the Whole of Government perspective Treasury is able to bring.

This office has observed that budget bids and the formal budget process are time consuming and often unsuccessful. This results in inadequate funding to continue ongoing restoration work.

This action relates to recommendation 2 of this report.

PAC REPORT RECOMMENDATION 2

The Committee recommends that the ACT Government improve transparency with regard to budget inflows and outflows for the management of the Lower Cotter Catchment and how these flows are apportioned across the two primary stakeholders involved—Icon Water which has responsibility for maintaining source water protection and the government agency(ies) with responsibility for land management.

Government response

Response: Agreed

Action: EPSDD, CMTEDD

Due date: February 2017

Status

Initiatives in progress that require ongoing attention

Government agencies will work together to ensure a summary of annual works plans, related to the ongoing management of the Lower Cotter Catchment that which are able to be reviewed publicly.

This will be achieved by creating dedicated online content on relevant government websites which will be updated quarterly. Information provided will include:

- summary of works to be completed, the aims, the objectives and timelines;
- responsible agency;
- regular updates including reasons for delays or postponement of works;
- estimated budget; and
- contacts for further information.

This office has observed that this has not occurred. There is no dedicated online content to reflect this commitment. As of 31 August 2018, the EPSDD Lower Cotter Catchment webpage has not been updated since 7 June 2017 and does not display current policies, the Reserve Management Plan 2018 or implementation plan.

This action relates to recommendation 3 of this report.

PAC REPORT RECOMMENDATION 3

The Committee recommends that the ACT Government report to the Assembly, by the last sitting day in March 2017, on the progress of the Government's implementation of the recommendations made in Auditor-General's Report No.3/2015: Restoration of the Lower Cotter Catchment, that have been accepted either in-whole or in-part. This should include: (i) a summary of action to date, either completed or in progress (including milestones completed); and (ii) the proposed action (including timetable), for implementing recommendations (or parts thereof), where action has not yet commenced.

Government response

Response: Agreed
Action: EPSDD
Due date: March 2017

Status

Recommendation met, no ongoing attention required

In February 2017 a report, addressing points (i) and (ii) was presented to the Assembly. A copy of the report was published on the Lower Cotter Catchment webpage of the EPSDD website.

PAC REPORT RECOMMENDATION 4

The Committee recommends that the responsible Minister inform the ACT Legislative Assembly by the last sitting day in March 2017 on progress with regard to the Commissioner for Sustainability and the Environment's evaluation of the restoration of the Lower Cotter Catchment.

Government response

Response: Agreed
Action: Responsible Minister
Due date: March 2017

Status

Recommendation met, no ongoing attention required

In February 2017 the Minister informed the Legislative Assembly of progress made by the Commissioner for Sustainability and the Environment in the evaluation of restoration works in the Lower Cotter Catchment.

PAC REPORT RECOMMENDATION 5

The Committee recommends that the ACT Government inform the ACT Legislative Assembly by the last sitting date in 2016 as to progress on the pine wildling removal trials within the Blue Range area. This should include detail on: (i) key milestones; (ii) trial outcomes concerning identification of removal methods that best align with the preservation of water; and (iii) a proposed timeline for implementation of pine wildling removal within the Lower Cotter Catchment.

Government response

Response: Agreed
Action: EPSDD
Due date: Last sitting day in 2016

Status

Recommendation met but with opportunities for additional initiatives to be considered

The Minister presented a report to the Assembly in 2016 on the pine wildling removal trial in Blue Range. After tabling, EPSDD committed to publishing a copy of this on the Lower Cotter Catchment webpage.

This office has observed that this has not occurred. There is no dedicated online content to reflect this commitment. As of 31 August 2018, the EPSDD Lower Cotter Catchment webpage has not been updated since 7 June 2017 and does not display current policies, the Reserve Management Plan 2018 or implementation plan.

This action relates to recommendation 3 of this report.

PAC REPORT RECOMMENDATION 6

The Committee recommends that the ACT Government prioritise the finalisation of the Lower Cotter Catchment Recreation Strategy. The Strategy, amongst other things, should include: (i) identification of controls on public access to the Catchment; and (ii) strategies to raise community awareness of the importance of access restrictions in protecting the water supply.

Government response

Response: Agreed in part

Action: EPSDD

Due date: End of 2016

Status

Recommendation met but with opportunities for additional initiatives to be considered

EPSDD has incorporated recreation into the Reserve Management Plan 2018 and considers strategic recreational issues within the broader context of overall management of the area.

For this reason the ACT Government does not intend to draft a standalone recreation strategy for the Lower Cotter Catchment.

The intent of the Committee's recommendation, to ensure appropriate controls on recreational activity and the need to lift awareness of catchment values, is addressed in the recreation chapter of the management plan. The chapter deals specifically with:

- identification of a primary management objective,
- recreational activities and managing impacts,
- managing visitor safety,
- catering for appropriate organised events,
- advice on specific allowable and disallowable activities, and
- specific actions to be completed by the land manager to support recreation management.

In order to comply with the intent of the PAC Report recommendation, it is important that actions relating to the topics listed above are included in the reserve management plan implementation plan.

This relates to recommendation 3 of this report.

PAC REPORT RECOMMENDATION 7

The Committee recommends that the ACT Government consider extending the program of native planting and habitat restoration for the Lower Cotter Catchment in partnership with the local community and community-based organisations and groups.

Government response

Response: Agreed

Action: EPSDD

Due date: Ongoing

Status

Recommendation met but with opportunities for additional initiatives to be considered

EPSDD will continue to engage with the community through the Uriarra Park Care Group, Greening Australia and other catchment management groups as appropriate.

Engagement will include community planting days, environmental rehabilitation projects, interpretation and education seminars and participation in Uriarra Village committee meetings.

Opportunities for community engagement will be communicated through appropriate channels including social and conventional media, and this will occur in partnership with the relevant community stakeholder.

This office has observed that this has not occurred. There is no evidence of an extended program of native planting with the community-based groups listed and opportunities for community engagement have been limited.

This relates to recommendation 3 of this report.

4.4 Professor Ian Falconer’s Comparative Assessment of Ecological Restoration 2015–2018

4.4.1 OVERVIEW

In compliance with Auditor-General’s recommendation 12, to evaluate ecological restoration efforts in the Lower Cotter Catchment as accurately as possible, a Terms of Reference for a comparative assessment was developed by this office.

To ensure rigorous comparative considerations, Professor Ian Falconer, the lead expert contributing to the Auditor-General’s Report No.3/2015, was engaged to conduct the comparative assessment and report on ecological restoration for the period 2015–18 using the same key criteria.

Professor Falconer’s assessment was conducted in consultation with this office, Parks and Conservation Service, and Icon Water over a series of four site visits from December 2017–February 2018.

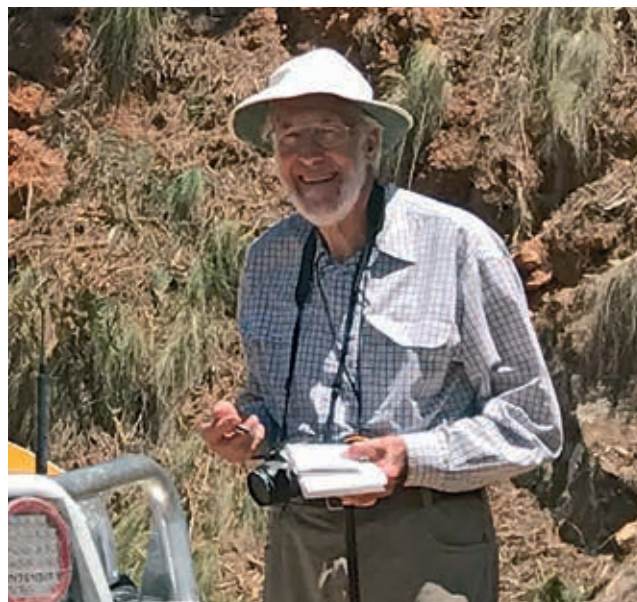
The focus of the assessment was to examine on ground restoration works to determine whether they have been effective in managing water quality, to provide science-based evidence of ecological improvements since 2015, and, to identify any emerging risks and key data gaps.

The assessment was based on observation and a limited amount of data.

4.4.2 ASSESSMENT CRITERIA

Matters for examination were:

- water quality (erosion control, road and trail management),
- vegetation management (weeds, native revegetation, pest control),
- fire management (fuel load, species resilience),
- research and monitoring,
- cultural heritage,
- recreation, and
- emerging risks.



*Professor Ian Falconer, site visit to Blue Range 2017.
Source: Caitlin Roy*

BLACKBERRY – THE THICKET AND THE THIN



*Blackberry infestation in Condor Creek sub-Catchment.
Source: Ian Falconer*

The status of blackberry

European blackberry (*Rubus fruticosus aggregate*) is an exotic plant species affecting land management activities in the Lower Cotter Catchment.

Regarded by the Commonwealth Department of Environment and Energy as a Weed of National Significance²⁴ because of its invasiveness, potential to rapidly spread, and economic and environmental impacts. Its harmful effects are well known.

In the Australian Capital Territory, with the exception of the permitted cultivars, existing plants of any of the *R. fruticosus* agg. species must be contained, and propagation and supply is prohibited.²⁵

Following near total decimation of the catchment after the 2003 bushfires and subsequent contour ripping, blackberry has invaded nearly one fifth of the catchment (approximately 1200 hectares of 6000 hectares),²⁶ particularly at lower altitudes, riparian areas, and along roadsides.

Complexity – can a weed have value?

Notwithstanding (and some might say because of) its status as a weed, blackberry is both a complex detractor and contributor to habitat and ecosystem management.

With its rapid growth, blackberry plays an important role in mitigating soil erosion, providing habitat and protection for small native birds compared to native plant species that take decades to regenerate.

Conversely, because of the propensity of blackberry to rapidly establish, it has outcompeted native species. It also provides food and shelter for pest animals such as rabbits and foxes, and restricts access for restoration activities. Another primary concern for catchment management is that blackberry thickets,

particularly after spraying, are a fire hazard due to the large amount of dead woody material left behind.

Although natural native revegetation and coordinated replanting of native species are the preferred management actions, resourcing and the sheer scale of the catchment have been limiting factors. Fast growing and resilient, blackberry has colonised vast expanses of highly erodible bare ground where preferred native species have failed.

In the absence of native species, blackberry has been effective in revegetating the catchment to protect water quality by stabilising bare soil that would otherwise run off directly into the Cotter Reservoir or adjoining tributaries.

Controlling blackberry

Treated primarily with herbicide and a small amount by slashing in more dense areas, blackberry management programs must be planned and sustained over blocks of at least four years.²⁷ The leaf rust fungus *Phragmidium violaceum*, is an introduced biological control agent that has slowed the rate of blackberry spread, but does not eradicate infestations.²⁸ The fungus occurs in most areas where blackberry is present across Australia, including the ACT, however, is only effective at reducing fruiting during cool and wet growing seasons.

Long-term control methods are needed to:

- improve native species regeneration and diversity,
- increase habitat for threatened species, and
- prevent incursions into adjoining areas, particularly Namadgi National Park.

'Blackberry will persist indefinitely in an area unless it is treated.'²⁹

Due to the extensive area of blackberry yet to be controlled, its weedy resilience and the excessive cost associated with removal, the preferred approach to eradication is to steadily establish native vegetation to a sufficient density to reduce further spread of blackberry.

Monitoring of these eradication and restoration efforts through mapping will assist in understanding the extent of the problem and the success of various treatment programs.

24 <https://www.environment.gov.au/biodiversity/invasive/weeds/publications/guidelines/wons/pubs/r-fruticosus.pdf> accessed 22 March 2018

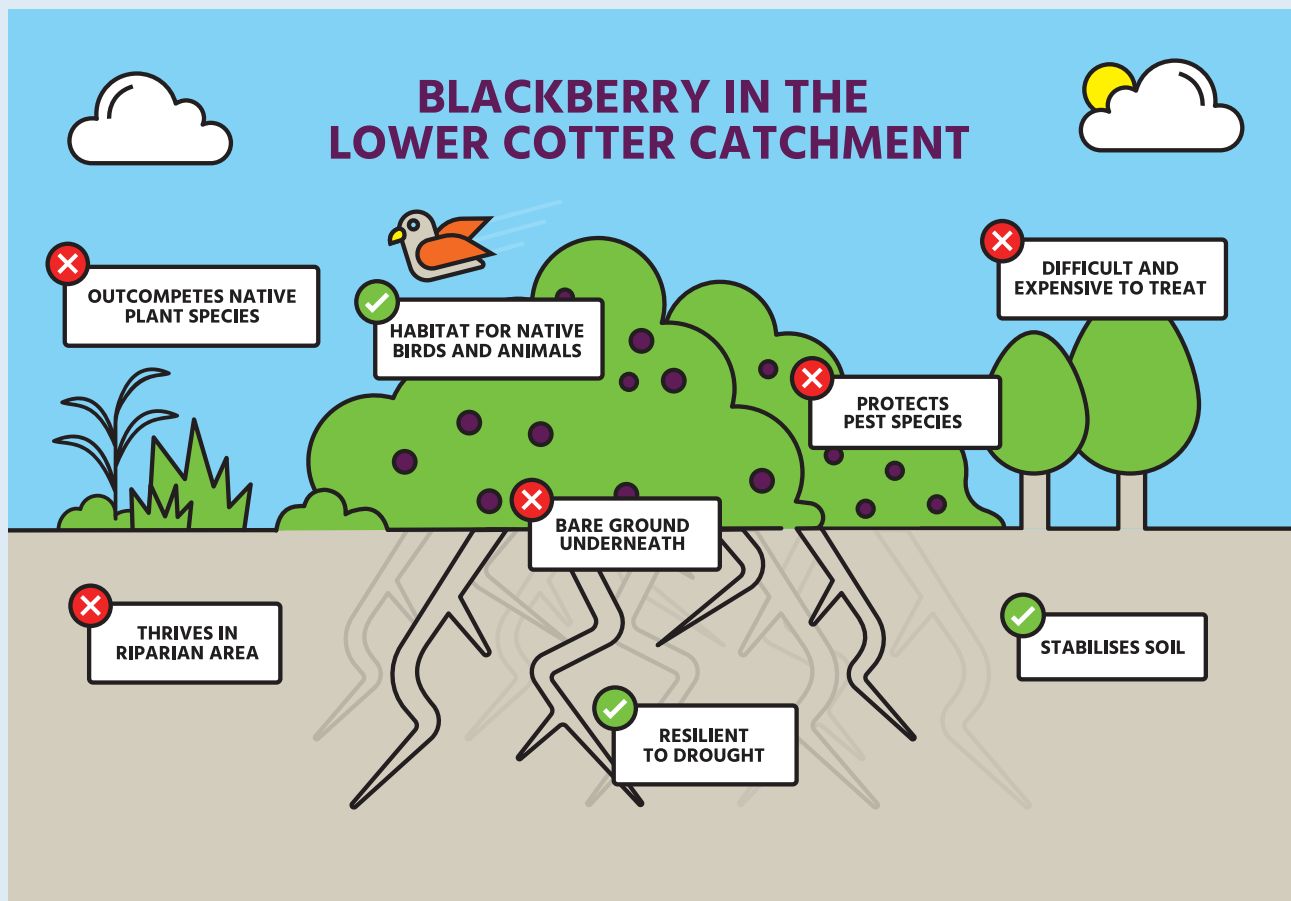
25 *Pest Plants and Animals Act 2005*

26 Pers. Comm. Email from Parks and Conservation Service, 2 February 2018

27 Pers. Comm., comments during Expert Reference Group meeting, Parks and Conservation Service, 9 February 2018

28 Morin, L. & K. Evans 2012. *Rubus fruticosus* L. agg. – European blackberry. In: *Biological control of weeds in Australia 1960 to 2010*, (eds. Julien M, Cruttwell McFadyen R, Cullen JM), 499-509. CSIRO Publishing, Collingwood, Australia

29 Australian Association of Bush Regenerators: http://www.aabr.org.au/images/stories/resources/ManagementGuides/WeedGuides/wmg_Blackberry.pdf accessed 25 March 2018



- **450** hectares treated
- **910** hectares of dense coverage remain
- **950** hectares of medium coverage remain
- **1,000** hectares of scattered coverage remain
- **\$2,000** per hectare primary treatment – dense stands require three treatments

**BLACKBERRY WILL PERSIST INDEFINITELY
UNLESS TREATED**

4.4.3 COMPARATIVE ASSESSMENT – SUMMARY FINDINGS

The Auditor-General's Report identified bushfires, exacerbated by dense regrowth of pine wildlings in steep and largely inaccessible areas, as the biggest risk to the Lower Cotter Catchment. Consequently, drastic remedial action is being undertaken, primarily in the Blue Range area, to remove and mulch pine wildlings.

It is essential that this action continues in the long-term to manage fire risk. While pine wildlings continue to be a problem in other areas of the catchment, the methods and actions taken to date are to be commended.

Erosion continues to impact water quality in the Cotter Reservoir and tributaries. Gully and creek restoration is underway, with effective soil remediation and replanting, particularly on compacted areas. The Pierces Creek area has received the most attention since 2015, however, turbidity in Condor Creek will require considerable work in the future.

To ensure long-term drinking water quality from this catchment, erosion management requires ongoing investment and remediation.

Weed management is also a persistent issue requiring intense management. Blackberry has spread extensively within the catchment and is a major focus of broad scale weed control. It is essential that natural vegetation is established as a long-term mechanism to control weeds, particularly blackberry and pine wildlings.

The need for research, recreation and cultural heritage management is considered in the Lower Cotter Catchment Reserve Management Plan 2018.

Research should be encouraged with facilitation by Parks and Conservation Service, and more broadly by EPSDD. Research outcomes can be integrated into management actions with appropriate data management and sharing measures.

Recreational use, access and impacts need rigorous and regular examination. The propensity for cars to be torched in the catchment is itself a substantial fire risk and human contamination of drinking water must be prevented by continuing to monitor access.

Cultural heritage has been considered in light of expanding the Cotter Reservoir, though there is a continuing need to focus on this which is not adequately recognised at present.

In conclusion, the work underway is effective and well managed given considerable limitations to budget, resourcing and changing environmental conditions. Ecological restoration and remediation of key risk areas is assessed as improving against all criteria.

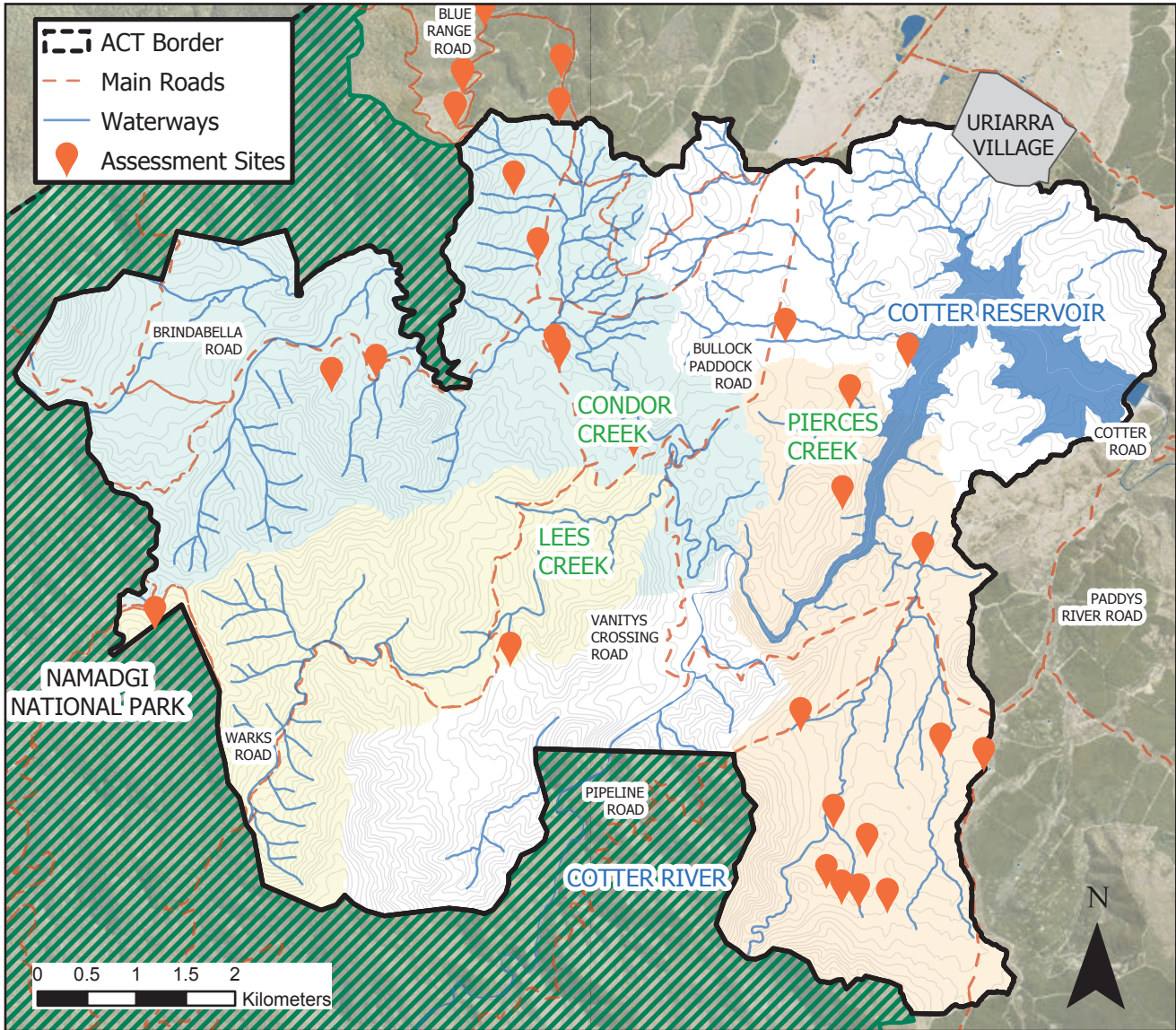
Since 2003, the ACT Government has contributed over \$410.5 million in capital works for the enlargement of the Cotter Reservoir and nearly \$10 million in remediation works to ensure a steady supply of quality drinking water for Canberra and the surrounding region.

It is critical that adequate funding, increased from the current level, is provided to continue long-term effective management of the catchment.

“If the catchment was left to naturally recover, with no further investment or human intervention, in 50 years from now it would be full of established pine wildlings in higher areas and erosion and blackberries in lower areas. This would be a catastrophic risk to water quality through fire, erosion and inability to manage pests.”

Professor Ian Falconer.

COMPARATIVE ASSESSMENT SITES FOR THE LOWER COTTER CATCHMENT



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Serena Farrelly and Jack Wales. Office of the Commissioner for Sustainability and the Environment, November 2018

*Note: Sub-catchment boundaries may not represent hydrological boundaries with complete accuracy due to the modelling scale.

CRITERIA	ASSESSMENT SUMMARY	OBSERVATION			DATA QUALITY		
		GOOD	FAIR	POOR	GOOD	FAIR	POOR
Fire fuel management	A significant amount of fuel reduction has occurred in key high risk areas, particularly in Blue Range. This has improved since 2015.		✓			✓	
Weed management	Pine wildling and blackberry infestations continue to proliferate throughout the catchment. While this has improved since 2015, control of these, along with other weeds, will require ongoing investment and management increased from the current level.		✓			✓	
Native revegetation	Native revegetation has increased across all sub-catchments and will continue to improve with weed and pest management activities.		✓				✓
Gully erosion and road remediation	Remediation of 500 metres of gully and 3700 metres of roads and tracks has been undertaken since 2003, resulting in an overall improvement. Focussing on managing erosion point sources will improve ongoing long term restoration efforts.		✓				✓
Water quality	Data has shown peak turbidities in the reservoir above the Australian and New Zealand Guidelines on several occasions in recent years, however the trend has shown a steady improvement as vegetation cover increases.		✓			✓	

4.5 Evaluation of Ecological Restoration Conclusions

This Evaluation broadly considers:

1. Whether Recommendations from the 2015 Auditor-General's Report have been or are being addressed effectively.
2. Whether Recommendations from the Standing Committee on Public Accounts review have been or are being addressed effectively.
3. Whether there has been improvement in the ecological condition of the Lower Cotter Catchment from 2015–18, demonstrated by comparative assessment and science-based evidence.
4. Whether restoration is being implemented against management objectives defined for a reserve set aside for the protection of water supply, demonstrated by comparative assessment and science-based evidence.

In evaluating each of these points, it is clear that a large amount of heroic work has been carried out effectively to address audit recommendations and management objectives. However, as articulated in the ACT Government's latest progress report, management to restore the Lower Cotter Catchment is very much a work in progress.

Responsibilities will not conclude with the completion of the Auditor-General's recommendations or management actions in the reserve management plan.

The key indicators of success are whether water quality is improving, and whether catchment soils and vegetation are stabilising. The Lower Cotter Catchment can provide opportunities to link study and monitoring of post-fire recovery to improving land management operations such as road decommissioning, vegetation restoration techniques and fire management.

The nature of effective land management in a changing environment is that it is adaptive and ongoing. The prolonged collective efforts to restore ecological values are clearly visible and in time, will be measurable as well. Implementation of the monitoring and evaluation framework will demonstrate this.

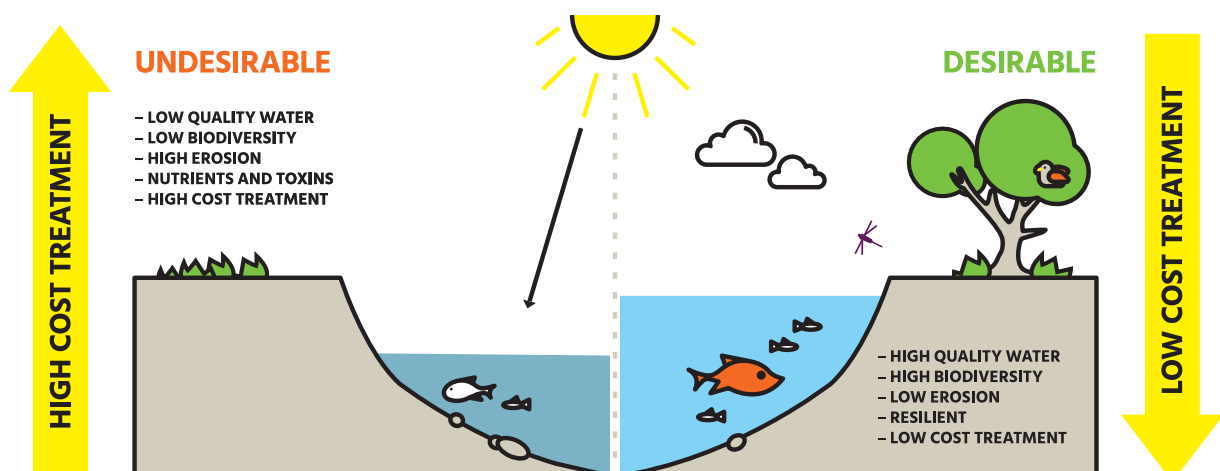
Climate change, population growth and imminent drought conditions are increasing risks to catchment values, and this is occurring while funding and resourcing dwindle.

Adequate one off and recurrent funding must be institutionalised to put the right price on the value of the Lower Cotter Catchment in securing Canberra's long-term water supply. The restoration of this reserve will take decades, and mitigating the fire hazard risk will be required in perpetuity.

Research shows that every \$1 invested in restoring degraded land generates an estimated \$7–\$30 in economic benefits, including improved ecosystem services, carbon sequestration, and water quality. Yet each year, deforestation and land degradation costs the world \$6.3 trillion in lost ecosystem services like recreational opportunities, and clean air and water.

Despite these clear costs and benefits, restoration receives only a tiny fraction of the funding it needs. That's where the government comes in.³⁰

COST AND RISK VS BENEFIT OVER TIME



30 http://www.wri.org/blog/2017/12/restoration-one-most-overlooked-opportunities-economic-growth%20?utm_campaign=wridigest&utm_source=wridigest-2017-12-19&utm_medium=email&utm_content=learnmore accessed 10 February 2018 accessed 11 February 2018.

TIME SERIES PHOTOS OF BLUNDELLS FLAT 2003-18



Blundells Flat 2003. Source: Mark Butz



Blundells Flat 2007. Source: Mark Butz



Blundells Flat 2018. Source: Serena Farrelly.

5.

Monitoring and Evaluation Framework for the Lower Cotter Catchment



5.1 Monitoring: A General Commentary

5.1.1 EFFECTIVE MONITORING AND ADAPTIVE MANAGEMENT

Monitoring is an essential component of environmental management.

The methodical collection of targeted data provides the knowledge and evidence required to:

- assess management effectiveness and progress towards achieving targets and objectives,
- assess the condition of ecosystems, natural resources and biodiversity,
- inform risk and adaptive management questions,
- develop integrated environmental research programs,
- design, implement, and evaluate effective environmental policies, and
- assist asset and land managers to make timely and effective decisions.¹

Adaptive management is an organised system of learning designed to reduce uncertainty inherent in ecosystem management.²

The adaptive management learning process consists of research and monitoring. However, monitoring has become the primary path for learning in adaptive management because of the time and cost constraints often associated with experimentation.³

Resources for appropriate monitoring need to be provided to inform the progress and outcomes of restoration projects. This includes assessing the baseline reference condition (or pre restoration project condition) to determine any changes resulting from restoration activities.

A successful long-term monitoring program relies on the provision of ongoing adequate funding, a core set of inexpensive measurements, and dedicated staffing to collect, interpret, and apply data findings to the adaptive management program.

Management plans for restoration projects need to clearly outline monitoring requirements to ensure goals and objectives are measured.

Consistency and relevance of monitoring data and information is critical to an adaptive management approach. Catchment management stakeholders need to have the right information to support decision making when reporting on investment.⁴

1 <https://www.mdba.gov.au/sites/default/files/archived/proposed/NRM-MERI-Framework.pdf> accessed 12 September 2018

2 Birge, H., Allen, C., Garmestani A. & K. Pope 2016. Adaptive management for ecosystem services. *Journal of Environmental Management* 183(Part 2):343-352

3 Lovett, G., Burns, D., Driscoll, C., Jenkins, J., Mitchell, M., Rustad, L., Shanley, J., Likens, G. & R. Haeuber. 2007. Who needs environmental monitoring? *Frontiers in Ecology and the Environment* 5(5):253–260

4 <https://www.mdba.gov.au/sites/default/files/archived/proposed/NRM-MERI-Framework.pdf> accessed 12 September 2018

5.1.2 MONITORING TO MANAGE RISK

Effective monitoring programs are targeted to address program objectives such as detecting specific environmental changes, or assessing the performance of management actions. Objectives need to consider both current environmental drivers and conditions, as well as those in future decades, to produce monitoring data with long-term value. This requires a good understanding of the system being monitored and informed projections of future conditions to anticipate environmental problems.

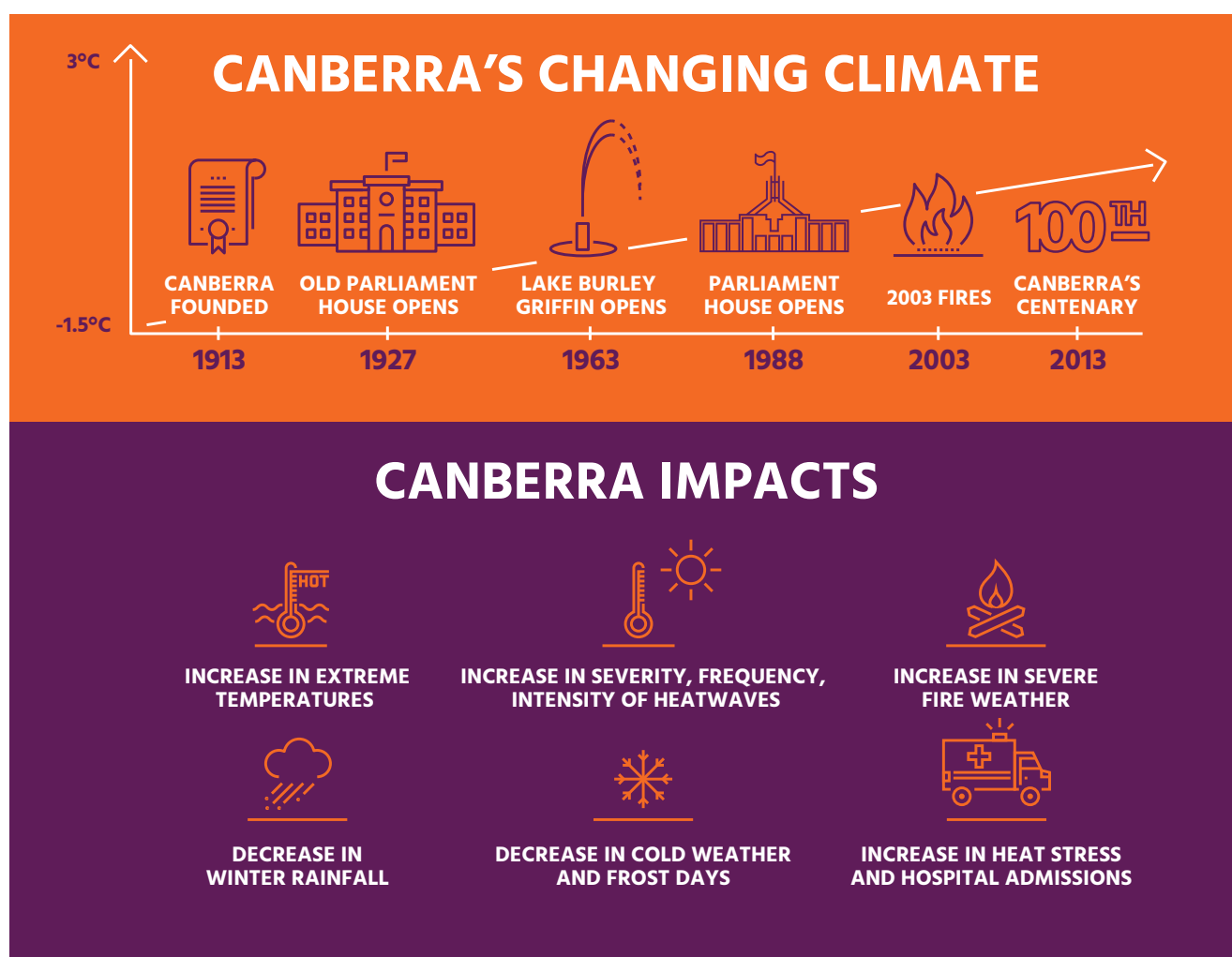
A good knowledge of the system is also important to enable the selection of key measures that are likely to be sensitive to change.

Effective monitoring programs may also incorporate the development and use of indicators to assess trends in critical processes, such as nutrient cycles, or known ecosystem drivers, such as precipitation.

An effective monitoring program must be designed using an informed risk based approach and the ability to adapt to change.

A good example of this is the imminent impacts of climate change. Climate projections indicate there is significant risk that extreme weather events will become more frequent and intense.⁵

This is reflected in the following infographic based on the analysis of specific climate change impacts in the ACT by Dr Sophie Lewis.⁶



5 University of Canberra, 2018. The Lower Cotter Catchment: monitoring and evaluation framework for the protection of water and ecological values

6 Office of the Commissioner for Sustainability and the Environment, 2017. Implementation Status Report on Climate Change Policy

Monitoring is required to provide consistent, good quality, relevant data to support actions needed to respond to a changing climate. This is considered in more detail in Chapter 7 of this report.

The occurrence of climate change events, such as fire or flooding, likely to pose a high risk to water quality and ecological values in the Lower Cotter Catchment need to trigger additional monitoring activities.⁷

5.1.3 CHALLENGES TO EFFECTIVE ECOLOGICAL MONITORING

It can be hard to demonstrate that ecological monitoring is worth the cost.

Monitoring often doesn't have visible or tangible outcomes during project implementation, and its benefits may not be immediately apparent. However, monitoring is the foundation for evidence-based adaptive management.

Monitoring can determine whether management objectives have been met, detect problems and prevent catastrophes.

Common criticisms of ecological monitoring are:

- that it doesn't have tangible benefits and diverts funds from on-ground works,
- that most monitoring data are never used,
- the data are incomplete or inconsistent, and
- it is difficult to determine the appropriate monitoring required now to inform questions in the future.⁸

These criticisms can be addressed by ensuring that the data is of high quality, that data and methods are broadly accessible and that monitoring programs are as cost effective and adaptive as possible.

In fact, limited funds can achieve a lot more if monitoring is targeted.⁹

Question driven monitoring is the most effective in terms of value for money and achieving outcomes.

5.1.4 EVALUATION

Evaluation encompasses periodic assessment of the appropriateness of a policy, program or project through a set of applied research techniques to generate systematic information that can help improve performance. It includes formal external, independent evaluations and self-evaluation processes to reinforce outcomes and ownership.¹⁰

Detailed analysis of data collected will allow evaluation of the effectiveness of management actions to support water quality and ecological restoration within the Lower Cotter Catchment.

This report recommends that monitoring and evaluation be implemented within an adaptive management approach to restoring the landscape and protecting water quality and ecological values. Outcomes will provide an evidence-base to inform continual improvement to the management system and decision making processes.¹¹

This relates to recommendation 1 of this report.

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7 University of Canberra 2018. The Lower Cotter Catchment: monitoring and evaluation framework for the protection of water and ecological values

8 Lovett, G., Burns, D., Driscoll, C., Jenkins, J., Mitchell, M., Rustad, L., Shanley, J., Likens, G. & R. Haeuber. 2007. Who needs environmental monitoring? *Frontiers in Ecology and the Environment* 5(5):253–260

9 Lindenmayer, D. & G. Likens 2018. Effective Ecological Monitoring. CSIRO Publishing, Collingwood, Australia

10 <https://www.mdba.gov.au/sites/default/files/archived/proposed/NRM-MERI-Framework.pdf> accessed 12 September

11 University of Canberra 2018. The Lower Cotter Catchment: monitoring and evaluation framework for the protection of water and ecological values

5.2 Existing Monitoring in the Lower Cotter Catchment

5.2.1 OVERVIEW

Water monitoring in the ACT is undertaken through a range of organisations and methods to serve specific purposes, such as drinking water quality or riparian health, at specific locations.¹²

To better support adaptive, evidence-based decision making and priorities for investment in water quality, a more integrated and coordinated water monitoring program is being developed.¹³

This includes the Lower Cotter Catchment, where current monitoring is very limited.

Water quality and land management in the Lower Cotter Catchment is currently monitored by government agencies and associated contractors, Icon Water, research organisations and volunteer groups. These monitoring activities tend to be project based and non-ongoing, which has limited effectiveness in supporting strategic objectives and systematic evaluation of management actions.

The gaps and limitations associated with current monitoring are:

- the non-ongoing nature of the monitoring,
- limited collaboration and sharing of information between stakeholders,
- limited identification of how current monitoring meets strategic objectives,
- inconsistent and fragmented data recording, making long-term data analyses for evaluation against management objectives or ecological trends through time very challenging, and
- the absence of early stage interrogation to identify appropriate monitoring questions.

5.2.2 ICON WATER

To ensure compliance with the Australian Drinking Water Guidelines,¹⁴ and their Licence to Take Water (WU67),¹⁵ Icon Water runs an ongoing and comprehensive water quality monitoring program that extends the stretch of the Cotter River.

However, within the Lower Cotter Catchment, Icon Water only undertakes water quality monitoring in the Cotter Reservoir and two other sites upstream of the reservoir. This is the extent of the monitoring to cover a 6000 hectare catchment.¹⁶

This monitoring, in combination with supply level analysis, is used to inform Icon's operational decisions.

Additionally, a program to monitor dissolved oxygen has been in place since the completion of the enlarged Cotter Dam as part of a fish management plan for the protection of the threatened Macquarie Perch population.¹⁷

Fact box

COMMON WATER QUALITY VARIABLES MEASURED BY ICON

- temperature,
- dissolved oxygen,
- turbidity,
- total organic carbon,
- iron and manganese,
- giardia and cryptosporidium, and
- chlorophyll and the algal community.

¹² ACT Government 2014. ACT Water Strategy 2014–44: Striking the Balance

¹³ ACT Government 2014. ACT Water Strategy 2014–44: Striking the Balance

¹⁴ Australian Drinking Water Guidelines 2011

¹⁵ Australian Capital Territory Licence to Take Water Under the *Water Resources Act 2007*

¹⁶ University of Canberra 2018. The Lower Cotter Catchment: monitoring and evaluation framework for the protection of water and ecological values

¹⁷ <https://www.iconwater.com.au/water-and-sewerage-system/our-projects/water-security-projects/enlarged-cotter-dam/protecting-native-fish-species.aspx> accessed 16 October 2018

ICON WATER'S FISH MANAGEMENT PLAN

As part of the construction of the new Cotter Dam, Icon Water implemented a comprehensive Fish Management Program to protect critical habitat for several endangered and/or threatened fish species, including the Macquarie Perch.¹⁸

A significant component was the construction of an extensive network of artificial rock reef habitats.



Fish habitat under construction at Cotter Reservoir. Image: Icon Water

The rock reef habitats provided new shelter for the fish with the enlarged reservoir inundating reed beds that were previously used for shelter.

The Fish Monitoring Program focusses on ten management questions¹⁹ that aim to:

- determine the impact of the filling and operation of the new Cotter Dam on populations of the two focal species (Macquarie Perch and Two-spined Blackfish) and potential threats (predators and competitors) in the new Cotter Dam and river upstream, and
- inform management actions to minimise and/or mitigate the impact to those populations.

The program includes ongoing water quality and ecological monitoring within and around the Lower Cotter Catchment. Three water quality monitoring buoys were installed in the Cotter Reservoir that collected dissolved oxygen and temperature information across the reservoir as part of this program.²⁰

5.2.3 ICON'S LICENCE TO TAKE WATER AND ENVIRONMENTAL FLOWS

Icon's water supply operations are controlled through their Licence to Take Water. This is issued by the Environment Protection Authority in consultation with ACT Health.

This licence enacts requirements for environmental flows and associated monitoring, which replace the natural flows that may be missing because the water is stored in reservoirs.

Environmental flow requirements are defined in the ACT in the 2013 Environmental Flow Guidelines. They are managed in the Cotter River to target protection of specific ecological values.

5.2.4 ABORIGINAL WATER ASSESSMENTS AND CULTURAL FLOWS

One of the actions in the ACT Government's Water Strategy 2014–44²¹ is to ensure that Indigenous and other cultural values are recognised in managing water in the ACT.²²

The Aboriginal Waterways Assessment Tool²³ was developed by the Murray Darling Basin Authority in partnership with Murray Lower Darling Rivers Indigenous Nations and the Northern Basin Aboriginal Nations. It is a tool used with Traditional Custodians on Country to assist in identifying heritage sites, cultural values and traditional use of local waterways.

Aboriginal Water Assessments have been undertaken during 2016 and 2017, and have helped build an exchange of knowledge between ACT Government and Traditional Custodians. Two sites have been identified within the Lower Cotter Catchment for ongoing management.²⁴

In addition to this, the Murray-Darling Basin Authority Plan evaluates the role of Traditional Custodians in determining environmental water regimes that conform to 'cultural flow' objectives.

Cultural flows are water entitlements that are legally and beneficially owned by Indigenous Nations of a sufficient and adequate quantity and quality, to improve the spiritual, cultural, environmental, social and economic conditions of those Indigenous Nations.²⁵

A Cultural Flows Guide for Indigenous Nations has been developed to monitor, evaluate and report on cultural flows to inform management and planning.²⁶

18 <https://www.iconwater.com.au/water-and-sewerage-system/our-projects/water-security-projects/enlarged-cotter-dam/protecting-native-fish-species.aspx> accessed 16 October 2018

19 Icon Water 2018. Report to the Commonwealth Department of the Environment and Energy: Annual Performance Report (2017) against the Enlarged Cotter Dam Fish Management Plan Version 3

20 Icon Water 2014, Enlarged Cotter Dam Fish Management Plan, Version 3, November 2013

21 ACT Government 2014. ACT Water Strategy 2014–44: Striking the Balance

22 ACT Government 2014. ACT Water Strategy 2014–44: Striking the Balance

23 <http://www.mldrin.org.au/> accessed 4 March 2018

24 <https://www.mdba.gov.au/sites/default/files/pubs/BPE-report-2017.pdf> accessed 20 September 2018

25 <http://www.mldrin.org.au/what-we-do/cultural-flows/> accessed 4 March 2018

26 <http://www.mldrin.org.au/wp-content/uploads/2018/06/Community-Guide.pdf> accessed 4 March 2018

A NEW PARADIGM IN WATER MANAGEMENT AND PLANNING FOR THE ACT – THE INCLUSION OF CULTURAL INDICATORS FOR NGUNNAWAL COUNTRY

Bradley J. Moggridge, Kamilaroi Water Scientist



The ACT Commissioner's Office has courageously journeyed into a new paradigm and is seeking to look outside the box. I commend the Commissioner and team and acknowledge and pay my respects to the Ngunnawal people, Traditional Custodians of the ACT, their Elders past, present and future.

Australia is considered the driest inhabited continent on Earth and has been the homeland of its First Peoples – Aboriginal people – who have been living, adapting, and thriving on this dry continent for 65,000 years.

This is no different for Australia's capital, Canberra and surrounding region, as the Ngunnawal people have been here for more than 25,000 years.

If it wasn't for their complex knowledge of Country and water, the Ngunnawal would not be here today.

They, the Ngunnawal, are experts in conservation and water management, fire management, and knowledge of flora and fauna through harvesting many natural resources, including:

- daisy yam,
- wattle seed,
- fish such as Murray cod and yellow belly,
- yabbies,
- platypus,
- water fowl,
- terrestrial mammals, and
- Bogong Moths in the summer months.

Ngunnawal people have a significant role in caring for their river Country through links to the Murrumbidgee River, Molonglo River and Cotter River, which form part of the broader Murray-Darling Basin. Their Country is also situated in the northern part of the Snowy Mountains which has strong links and pathways to the coast from the mountains.

However, this all changed in the early part of the 1800s when the Ngunnawal's world as they knew it was turned upside down with the arrival of the European invaders establishing farms and settlements. Many Aboriginal people in the region, including the Ngunnawal, were forcibly removed from their Countries and placed in missions and reserves across NSW which were managed by the Aboriginal Protection Board, mostly with foreign religions and doctrines replacing the Dreaming and Aboriginal Lore.

The destruction of a longstanding culture and language was a detriment to the people of the ACT.

We travel forward to 2018, and find that Aboriginal people's connection to Country and water has not changed or wavered as cultural obligations are still in place.

Behrendt and Thompson²⁷ recognised the important role of Aboriginal peoples in their statement:

"Aboriginal peoples have much to offer and society has much to gain by negotiating an empowering role for Aboriginal people in river management. A proper recognition of the Aboriginal role in river management will be an important step in establishing the economic, cultural and biological diversity necessary for a sustainable and just society."

The water-dependent cultural values of Aboriginal people are poorly understood, and hence, are rarely implemented in policy decisions for water quality and quantity.

27 J. Behrendt & P. Thompson, 2003. The Recognition and Protection of Aboriginal Interests in NSW Rivers, Healthy Rivers Commission of New South Wales

This is well documented in water management as change continues to be a slow process, despite several National Water Commission (NWC) reviews.²⁸ In its 2014 review, the NWC found that most jurisdictions had:

“... generally failed to incorporate effective strategies for achieving Indigenous objectives in water planning arrangements. While recognition of Indigenous cultural values and associated water requirements has progressed, implementation of practical change remains variable, with most jurisdictions as yet not making specific provision for water access for Indigenous people.”²⁹

Most recently, the Productivity Commission released its review of National Water Reform and the National Water Initiative,³⁰ noting the slow pace of change.

The ACT is in a strong position with good will and commitment to consider Aboriginal values of Country, through establishing Cultural Indicators. Partnerships with Aboriginal people will be both crucial and pivotal to this change.

The opportunity for Aboriginal people in the ACT to engage at an equal level in land and water management is improving. This is changing considerably as Aboriginal Knowledge and Aboriginal Science becomes more valuable and valued.

There have been advances, with a shift to seek and include Aboriginal Knowledge and Aboriginal Science into Natural Resource Management. This is mainly in cultural heritage management (as it is legislated), but also in Fire Ecology (Cultural Burning), Weather Knowledge (Seasonal Calendars and Climate), and National Park Management (Co-Management) sectors.

Water Quality management has also progressed. In 2009 Australian and New Zealand Environment

Ministers resolved to revise the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000³¹ and tasked a Joint Steering Committee to oversee the revision process. A key component of the review was to prepare guidance for the inclusion of cultural and spiritual values into water quality management.

The importance of water in this context is described below:

“Water is considered by Indigenous people to be a sacred gift that is critical to their identity and existence as well as economic importance. Its protection is bound by traditional lore and customs, which provide a system of sustainable management ensuring healthy people while exercising custodial responsibilities to manage parts of customary lands.”³²

The initial step for the review and consideration of Cultural and Spiritual Values was the preparation of guiding principles. The two principles developed were:

1. All Indigenous people, who have rights and obligations to the body of water being managed, are ensured prior informed consent through adequate consultation.
2. When developing or undertaking activities on a body of water, consideration should be given as to the Indigenous Cultural and Spiritual Values of the site.

While long overdue, these guiding principles were finally publicly released in 2018.

In a new paradigm of environmental reporting, the ACT has begun to implement cultural indicators for Ngunnawal Country, measuring cultural health through indicators of land, water and sky.

92

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28 <http://nwc.gov.au/> - 2009, 2011, 2013, 2014

29 <http://webarchive.nla.gov.au/gov/20160615062247/http://www.nwc.gov.au/publications/topic/assessments/australias-water-blueprint-national-reform-assessment-2014>

30 <https://www.pc.gov.au/inquiries/completed/water-reform#report>

31 Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000

32 B. Moggridge & R. Mihiniui, 2010. Indigenous principles for water quality - <http://www.waterquality.gov.au/anz-guidelines/guideline-values/derive/cultural-values/principles>

VALUING WATER IN A NEW WESTERN TRADITION – ENVIRONMENTAL ECONOMIC ACCOUNTING

On 27 April 2018 the meeting of Commonwealth, State and Territory environment ministers endorsed a strategy to deliver a common national approach to environmental-economic accounting in Australia.

Environmental-economic accounting helps to understand the condition of the environment, and its relationship with the economy.³³ The System of Environmental-Economic Accounting³⁴ supports the development of the accounts.

The Australian Bureau of Statistics³⁵ has produced environmental-economic accounts annually. Similarly, the Bureau of Meteorology produces annual water accounts. Beyond this work, there have been State and Territory efforts to integrate environmental and economic information into decision making including the piloting of accounts at different scales and timeframes.³⁶

The Australian National University has also produced accounts using the concepts described in the System of Environmental-Economic Accounts framework.³⁷

A water account for the ACT combining State and Federal agencies is under development and is the first of its kind.

An example of the potential for use of environmental accounts is found in the Proof of Concept developed by the ACT Commissioner for Sustainability and the Environment.³⁸ These accounts outlined the values associated with:

- land,
- environmental condition,
- biodiversity,
- water,
- air emissions,
- solid waste, and
- environmental expenditure.

5.2.5 MONITORING BY PARKS AND CONSERVATION SERVICE

Parks and Conservation Service undertakes a range of risk and project based monitoring activities relating to land management. Some of these are outlined in the following table:

MANAGEMENT ACTIVITY	MONITORING TYPE	RESPONSIBLE AREA
Fire fuel reduction	LiDAR derived fuel maps, canopy height and density	Fire, Forests and Roads
Burn severity	Water quality monitoring (sediment traps, turbidity monitors and rainfall gauges), post-fire hydrological risk evaluation at burn locations	Fire, Forests and Roads
Sediment load	LiDAR and aerial imagery analysis, combined with ground survey methods	Murrumbidgee River Corridor District Office
Vegetation (native and derived)	Landscape Function Analysis, native plant species richness, replanting survival rates, blackberry mapping, herbicide monitoring	Murrumbidgee River Corridor District Office
Pest animals	Scatter count, surveillance monitoring, LiDAR, browsing plots, presence/absence monitoring (transect scatter-counts)	Murrumbidgee River Corridor District Office

33 <http://www.environment.gov.au/science/environmental-economic-accounting> accessed 12 July 2018

34 <https://seea.un.org/> accessed 12 July 2018

35 <http://www.abs.gov.au/ausstats/abs@.nsf/mf/4655.0> accessed 12 July 2018

36 <http://www.environment.gov.au/science/environmental-economic-accounting> accessed 12 July 2018

37 http://www.environmentcommissioner.act.gov.au/__data/assets/pdf_file/0012/1106301/Environmental-Economic-Accounts-for-ACT-state-of-the-environment-reporting_Proof-of-Concept-A151125412.pdf accessed 12 July 2018

38 http://www.environmentcommissioner.act.gov.au/__data/assets/pdf_file/0012/1106301/Environmental-Economic-Accounts-for-ACT-state-of-the-environment-reporting_Proof-of-Concept-A151125412.pdf accessed 12 July 2018

5.2.6 CONSERVATION EFFECTIVENESS MONITORING PROGRAM (CEMP)

A review of monitoring in ACT Reserves in 2014 revealed that current monitoring programs were ‘data rich but information poor’.³⁹

The Conservation Effectiveness Monitoring Program (CEMP) is an overarching ecosystem condition monitoring framework for the ACT that has been developed to address this.

CEMP aims to create a coordinated, systematic, and robust biodiversity monitoring program that will:

- allow the detection of changes in ecosystem condition within reserves,
- evaluate the effectiveness of management actions in achieving conservation outcomes, and
- provide evidence to support land management decisions.

CEMP will identify existing monitoring programs that could be improved through better question driven monitoring.

A key component of the program is to develop monitoring plans for the eight identified ecosystem units within the ACT reserve system, which includes the Lower Cotter Catchment. This work will take several years to complete.

The Aquatic and Riparian CEMP is currently being drafted and is expected to be finalised in late 2018. Metrics and indicators, subject to change, for use in the Aquatic and Riparian CEMP will be integrated into the Lower Cotter Catchment Monitoring and Evaluation Framework.

For consistency across ACT programs, this report recommends aligning CEMP and Lower Cotter Catchment monitoring and evaluation programs where they can meet shared objectives. This relates to recommendation 1 of this report.



94
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95

Upstream end of Cotter Reservoir and Sugarloaf Hill from Sinclair Circuit. Source: Caitlin Roy

³⁹ https://www.environment.act.gov.au/__data/assets/pdf_file/0004/1059241/Conservation-effectiveness-monitoring-program.pdf accessed 22 May 2018

5.2.7 RESEARCH AND EDUCATION

Many scientific investigations have taken place in the Lower Cotter Catchment, ranging from detailed investigations of hydrology in the 1960s through to a suite of studies addressing the effects of the 2003 bushfires. Many of these projects have been targeted to restoration efforts but are sporadic and non-ongoing in nature.

More recent published scientific papers from the Lower Cotter Catchment have focussed on aquatic biology. A number of these studies have described the biological effects of stressors including drought, flow regulation, fire, land-use change and invasive fish species.

From 2004 to the present, 21 monitoring projects have been identified in the Lower Cotter Catchment, covering fish, frogs, fire response and management, turbidity, waterway condition and catchment vegetation.

These projects are quite specific spatially and temporally, and while data analysis can be extrapolated to some extent, consistent, more targeted monitoring is required to reflect the Reserve Management Plan 2018.

Past studies undertaken in the Cotter Catchment are extremely useful for:

- the development of cause and effect relationships,
- identification of ecological values and assets, and
- developing monitoring objectives and targets or trigger values.

They can also in some cases (particularly with respect to water quality and fish populations) provide a pseudo-baseline for future assessments. Information gleaned from past studies will help to determine a monitoring program in terms of what to measure, appropriate sites, and, when and how often to monitor.

However, there are limitations in utilising past studies for developing and implementing a monitoring framework.

First, and perhaps most critical, is that most of the past studies of the Lower Cotter Catchment have been restricted in both extent and time. Second, the aims may not align with the objectives of the current Reserve Management Plan 2018.



V-notch weir at the base of Blue Range monitoring sediment run-off post pine wildling removal trial. Source: Ian Falconer

5.3 Water Specific Monitoring: National Water Quality Management Strategy

The National Water Quality Management Strategy 2000 (NWQMS)⁴⁰ is a nationally agreed set of policies, processes and guidelines jointly developed by the Agriculture and Resource Management Council of Australia and New Zealand⁴¹ and the Australian and New Zealand Environment and Conservation Council (ANZECC).⁴²

The policy objective of the NWQMS is to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development.

The NWQMS provides an overarching framework for catchment management and water quality management. The Australian Drinking Water Guidelines (ADWG)⁴³ provide the rationale to support catchment management for drinking water.

The ANZECC guidelines and ADWG provide a framework for applying identified water quality measures to protect aquatic ecosystems.

5.4 Australian Drinking Water Guidelines

The ADWG provide a framework, developed using the best available scientific evidence, for good management of drinking water supplies to assure safety of water at the point of use.

The ADWG defines drinking water as water intended primarily for human consumption and applies to any water intended for drinking, irrespective of the source. The drinking water system is defined as everything from the point of collection of the water and includes the catchment.

5.5 Lower Cotter Catchment Monitoring and Evaluation Framework

5.5.1 DEVELOPMENT OF THE LOWER COTTER CATCHMENT MONITORING AND EVALUATION FRAMEWORK

While undertaking this restoration evaluation it became apparent that there was a distinct lack of consistent and targeted monitoring in the Lower Cotter Catchment to assess risk, support restoration activities, and inform long-term adaptive management.

To address this gap, this office developed a monitoring and evaluation framework specifically for the Lower Cotter Catchment. When implemented, this framework will provide the basis for future evaluations and statutory reporting against management objectives and actions contained in the reserve management plan.

This framework was developed in consultation with the Expert Reference Group and key stakeholders from EPSDD and Icon Water. The Institute of Applied Ecology, University of Canberra and Arup were engaged to provide technical expertise.

5.5.2 THE BENEFIT OF A RISK BASED APPROACH

Risks and major drivers of stress identified in the Reserve Management Plan 2018 and Risk Treatment Plan were used to:

1. identify gaps in activity-based and long-term data,
2. identify and understand short-term and long-term risks to water quality and ecological values, and
3. provide evidence to inform adaptive management decisions.

Risk factors and major stressors and their interrelationship with catchment values are outlined in the following infographic.

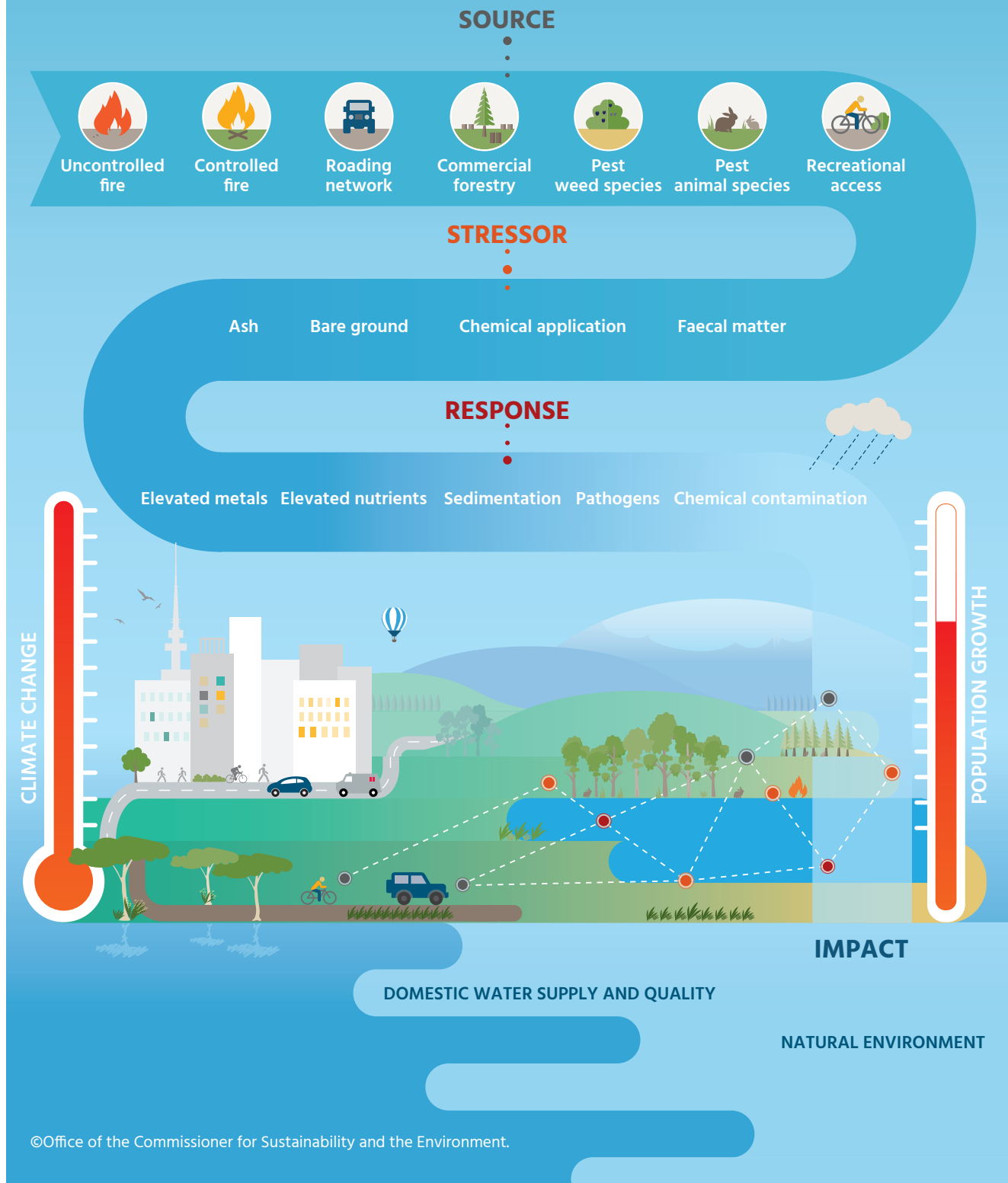
⁴⁰ The National Water Quality Management Strategy 2000

⁴¹ <http://www.waterquality.gov.au/anz-guidelines/resources/previous-guidelines/anzecc-armcanz-2000> accessed 1 December 2017

⁴² <http://www.waterquality.gov.au/anz-guidelines/resources/previous-guidelines/anzecc-armcanz-2000> accessed 1 December 2017

⁴³ Australian Drinking Water Guidelines 2011

Risk factors influencing the Monitoring and Evaluation Framework



Priorities for monitoring outlined in the Reserve Management Plan 2018 include:

- water quality and in-stream health of streams and the reservoir,
- the biological condition of streams flowing through with particular focus on stream turbidity linked to operational activities,
- the status of threatened aquatic fauna and other aquatic fauna, including alien species,
- the structure of vegetation communities,
- the condition of naturally regenerating areas and areas that may require more direct management or intervention,
- the progress, impact and outcomes of operational activities,
- recreational activities, and
- the level of support and understanding amongst visitors and the wider Canberra community of the Lower Cotter Catchment's role in providing potable water.

5.5.3 SCOPE FOR THE MONITORING AND EVALUATION FRAMEWORK

Scope for the Lower Cotter Catchment Monitoring and Evaluation Framework was based on developing water quality guidelines using the NWQMS framework and ecological and activity-based monitoring to reflect the Reserve Management Plan 2018. This included:

- drinking water quality guidelines,
- a risk-based approach to monitoring ecological values and restoration works,
- indicators and targets,
- a monitoring and assessment program (e.g. sites, type, equipment, intervals), and
- the ability to adapt over time and with certain events.

Monitoring related to Cotter Reservoir waters and offtake waters is the responsibility of Icon Water and outside the direct scope of this monitoring and evaluation framework.

This framework does consider Icon Water's existing monitoring in the development of indicators, targets and triggers for event-based monitoring.

In developing the framework, the following factors were considered:

- current condition of the catchment and its associated water courses,
- current land management priorities including fire management,
- existing monitoring programs by Icon, ACT Government and other key stakeholders,
- previous analysis of the catchment and its water quality systems, and
- critical knowledge and information gaps.

5.5.4 CONDUCTING A DESKTOP ANALYSIS

A desktop analysis reviewing existing datasets, research and documentation was undertaken to identify gaps and inform the risk-based approach.

Summarising previous work provides a valuable basis for defining the relationships between risks, stressors and key values, and in determining what indicators may be informative in the monitoring and evaluation context.

5.5.5 ANSWERING KEY QUESTIONS TO INFORM THE MONITORING AND EVALUATION FRAMEWORK

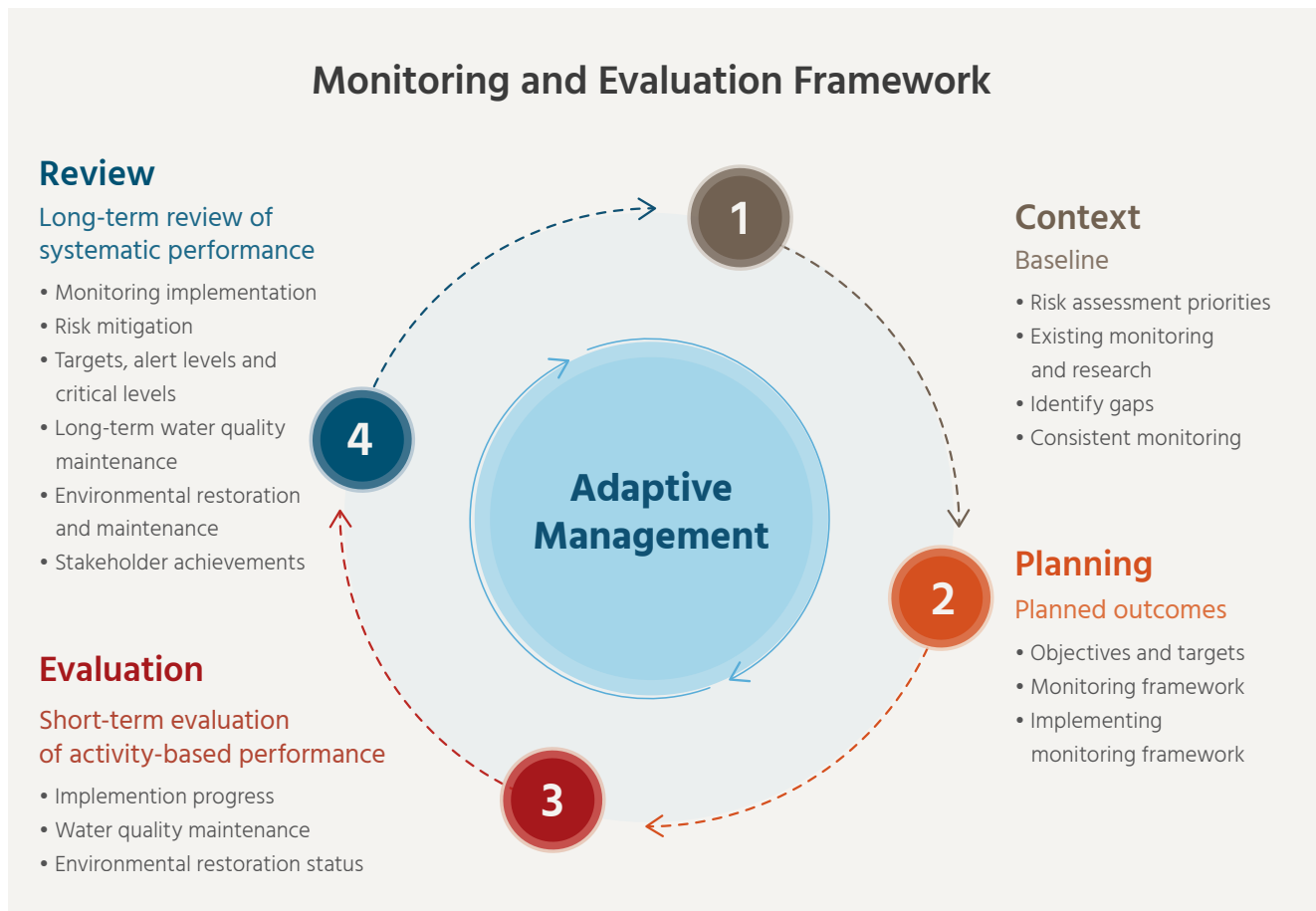
Based on this information, key questions informing the framework are:

1. What are the major sources of sediment and turbidity entering the Cotter Reservoir directly and via tributaries when monitored at regular intervals and following extreme weather events? This may include controlled and uncontrolled fire.
2. What are the main risks (e.g. sediment, turbidity, metals, nutrients, pathogens, pesticides) likely to affect drinking water quality and what are the relevant indicators and thresholds?
3. What are the main risks (e.g. fire, erosion, ground cover, exotic plants and animals, climate change, water quality) likely to affect ecological values, and what are the relevant indicators and thresholds?
4. How will the changing environment affect drawdown levels in terms of stratification and eutrophication of the Cotter Reservoir as a drinking water source?

5.6 Lower Cotter Catchment Monitoring and Evaluation Framework

5.6.1 THE FRAMEWORK: THEORY

The following diagram outlines an overarching strategic planning and improvement process required to understand, implement and improve water quality and protect ecological values in the Lower Cotter Catchment in line with the National Water Quality Management Strategy.



5.6.2 STAGED APPROACH (BASELINE, RISK AND ACTIVITY-BASED, LONG-TERM)

Any monitoring and evaluation framework must consider the elements identified in adaptive management cycles.

Consequently, this monitoring and evaluation framework has been designed to align implementation with the high, medium and low priority management actions outlined in the reserve management plan.

This is explained in detail in the following table:

STAGE	DETAILS
Stage 1: First 3 years Baseline program	<ul style="list-style-type: none"> • Baseline minimum level of monitoring and evaluation – establish the current basis of indicators and activities in the Lower Cotter Catchment. • Baseline program reviewed annually and in detail at year three and adjusted based on findings – expected to continue as the minimum level of monitoring to be conducted as part of Stages 2 and 3. • Requires coordination, collation and analysis of historical and all agency data to be connected across agencies. ACT Government Data Lake custodian of data. Data analysis and interpretation to be undertaken. • It is understood that some elements are currently undertaken and that coordination and collaboration will be required, rather than new resourcing.
Stage 2: 3 to 5 years Targets and triggers	<ul style="list-style-type: none"> • Mid-term monitoring program as an enhancement of the baseline program in a number of sites. The sites to be added will be determined after review of the Stage 1 findings. Five additional sites are proposed. • Activity based and event monitoring is coupled with mid-term monitoring to enable evaluation of the impact of activities. Mid-term monitoring builds on baseline to develop targets and triggers for drinking water quality risks. • Activity based events may also be monitored during Stage 1 to capture events that may occur within the first three years. Aim for 3 events to be monitored per activity type. Activities to be targeted include controlled fire and road network restoration. • It is understood that some elements are currently undertaken and that coordination and collaboration will be required, rather than new resourcing.
Stage 3: 5 to 10 years Restorative program	<ul style="list-style-type: none"> • Restorative assessment based monitoring to establish and understand the restorative status of the Lower Cotter Catchment. • Activity based events to include commercial forestry harvest, anticipated in more than ten years' time. If occurs earlier, then this activity should be monitored at that time. • Contribute to research and sub-catchment level monitoring to assess restoration of the Lower Cotter Catchment. • Plausible to focus on Pierces Creek which is currently highly degraded.

5.6.3 MONITORING PROGRAM

The monitoring component of the Lower Cotter Catchment Monitoring and Evaluation Framework is outlined in the following table:

LOWER COTTER CATCHMENT MONITORING PROGRAM

RISK	ACTIVITY	INDICATOR	HOW	WHERE	WHEN	WHO
Sediment	Road network	NTU (mg/L)	Probe	5 Sites	Online continuous	Icon Water
	Controlled fire	Rainfall (mm)	Probe / gauge	5 Sites	Online continuous	Icon Water
	Uncontrolled fire	Metals suite*	Grab	5 Sites	Quarterly	Icon Water
	Recreational access	Solids suite ^	Grab	5 Sites	Quarterly	Icon Water
	Pest animal species	Nutrients suite #	Grab	5 Sites	Quarterly	Icon Water
	Commercial forestry	Gully erosion assessment	LiDAR and aerial imagery analysis, combined with ground survey methods (erosion/deposition pins, marker flags, cross-sections) measuring gully evolution	Lower Cotter Catchment	Annually	Land manager, PCS
		Bare ground %	Spectroscopic analysis of existing ACT Gov annual RGB aerial imagery	Sub-catchment level	Annually	Land manager, PCS
		Traffic	Traffic counters 3 induction-loop counters permanently installed	6 primary vehicular access points	Monthly data retrieval	Land manager, PCS
		Road to Waterway connectivity kms % road network closed	Remote sensing and ground survey Sediment traps	Whole Lower Cotter Catchment	Annually	Land manager, PCS
		NTU (mg/L)	Probe	5 baseline + 5 additional Sites	Online continuous	Icon Water
		Rainfall (mm)	Probe / gauge	5 baseline + 5 additional Sites	Online continuous	Icon Water
		Metals suite*	Grab	5 baseline + 5 additional Sites	Quarterly	Icon Water
		Solids suite ^	Grab	5 baseline + 5 additional Sites	Quarterly	Icon Water
		Nutrients suite #	Grab	5 baseline + 5 additional Sites	Quarterly	Icon Water
		Gully erosion assessment	LiDAR and aerial imagery analysis, combined with ground survey methods (erosion/deposition pins, marker flags, cross-sections) measuring gully evolution	Whole Lower Cotter Catchment	Annually	Land manager, PCS
		Bare ground %	Spectroscopic analysis of existing ACT Gov annual RGB aerial imagery	Sub-catchment level	Annually	Land manager, PCS
		Traffic	Traffic counters 3 induction-loop counters permanently installed	6 primary vehicular access points	Monthly data retrieval	Land manager, PCS

RISK	ACTIVITY	INDICATOR	HOW	WHERE	WHEN	WHO
		Vegetation mapping	Native plant species richness, riparian biometric condition score, native species cover, median canopy height, existing LFA and floristics mapping	Lower Cotter Catchment total (replicated transect sites across the major vegetation communities)	2020 / 2022 / 2025	Land manager, PCS
		Sediment Budget	Model	Lower Cotter Catchment total and by Lower Cotter Catchment sub-catchment	2020 / 2022 / 2025	Land manager, PCS
		Pest Animal Species	Scat count Presence / absence Scent Lure Lidar Browsing plots Combined rabbit, deer and macropod presence/absence monitoring (transect scat-counts) across the six vegetation types (natural and derived). Pig presence/absence monitoring (ripping) in Blundells Flat Carex Fen. Camera traps	Lower Cotter Catchment total and by Lower Cotter Catchment sub-catchment	Seasonally (bi-annually)	Land manager, PCS
Controlled Fire – event monitoring Conduct for 3 events		NTU (mg/L)	Probe	2 sites – one upstream and one downstream from burn area	Online continuous: 1. Before burn 2. At least 6 months post burn (and until returns to pre burn level)	Fire, Forests and Roads, PCS
		Rainfall (mm)	Probe / gauge	2 sites – one upstream and one downstream from burn area	Online continuous: 1. Before burn 2. At least 6 months post burn (and until returns to pre burn level)	Fire, Forests and Roads, PCS
		Metals suite*	Grab	2 sites – one upstream and one downstream from burn area	Before burn 3 months post burn 6 months post burn	Fire, Forests and Roads, PCS
		Solids suite ^	Grab	2 sites – one upstream and one downstream from burn area	Before burn 3 months post burn 6 months post burn	Fire, Forests and Roads, PCS
		Nutrients suite #	Grab	2 sites – one upstream and one downstream from burn area	Before burn 3 months post burn 6 months post burn	Fire, Forests and Roads, PCS
		Bare ground %	Spectroscopic analysis RGB aerial imagery	Proposed burn area	Before burn 3 months post burn 6 months post burn	Land manager, PCS

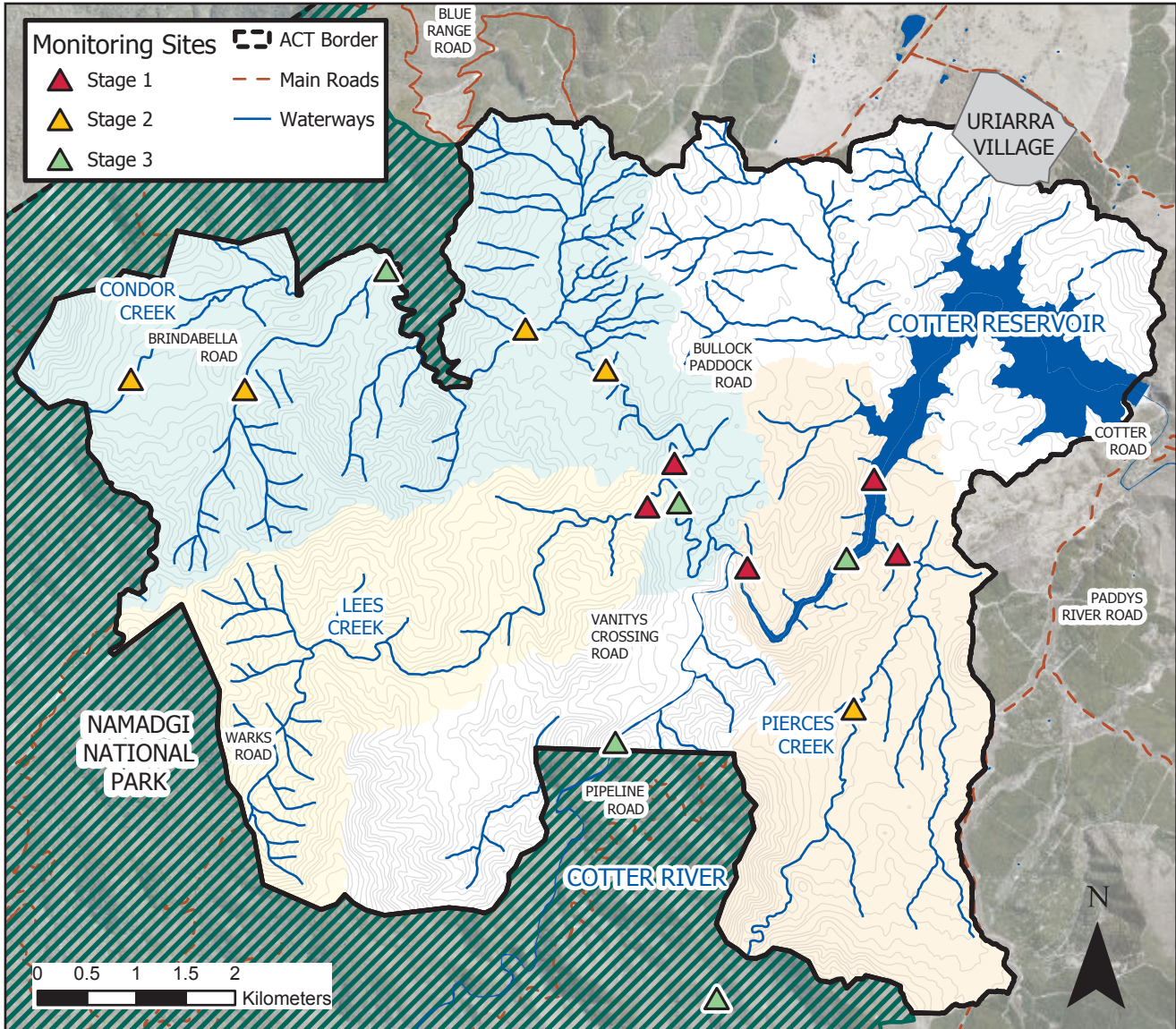
RISK	ACTIVITY	INDICATOR	HOW	WHERE	WHEN	WHO
		Fire parameters	LiDAR derived fuel map Canopy top height Leaf cover fraction Canopy fuel Vegetation cover Fire severity Fuel load	Proposed burn area	Before burn 3 months post burn 6 months post burn	Fire, Forests and Roads, PCS
	Road Network (made dormant or extinct) – event monitoring Conduct for 3 events / areas	Bare ground %	Spectroscopic analysis RGB aerial imagery	Across activity area	Bi-annually	Land manager, PCS
		Vegetation mapping	Landscape Function Analysis, native plant species richness, riparian biometric condition score, native species cover, median canopy height	Across activity area	Bi-annually	Land manager, PCS
		Weed species parameters	Vegetation mapping Presence / absence	Across activity area	Bi-annually	Land manager, PCS
		Road to Waterway connectivity kms % road network closed	Remote sensing and ground survey	Across activity area	Bi-annually	Land manager, PCS
	Forestry harvest activity	NTU (mg/L)	Probe	2 sites – one upstream and one downstream from pine harvest area	Online continuous: 1. Before harvest 2. Up to 6 months post harvest (or until returns to pre harvest level)	Fire, Forests and Roads, PCS
		Rainfall (mm)	Probe / gauge	2 sites – one upstream and one downstream from pine harvest area	Online continuous: 1. Before harvest 2. Up to 6 months post harvest (or until returns to pre harvest level)	Fire, Forests and Roads, PCS
		Metals suite*	Grab	2 sites – one upstream and one downstream from pine harvest area	Before harvest 3 months post harvest 6 months post harvest	Fire, Forests and Roads, PCS
		Solids suite ^	Grab	2 sites – one upstream and one downstream from pine harvest area	Before harvest 3 months post harvest 6 months post harvest	Fire, Forests and Roads, PCS
	Cotter Reservoir increasing source as drinking water supply (reservoir drawdown)	Sediment model	Model	Across Enlarged Cotter Reservoir – spatial and depth	Annually during draw down	Icon Water
Herbicides	Pest weed control	Herbicides	Grab	5 Sites	Quarterly	Icon Water
		SOP	Audit	Desk top	Annually	Land manager, PCS
		Herbicides	Grab	5 baseline + 5 additional Sites	Quarterly	Icon Water

RISK	ACTIVITY	INDICATOR	HOW	WHERE	WHEN	WHO
Pesticides	Pest animal control	Pesticides	Grab	5 Sites	Quarterly	Icon Water
		SOP	Audit	Desk top	Annually	Land manager, PCS
		Pesticides	Grab	5 baseline + 5 additional Sites	Quarterly	Icon Water
Pathogens	Pest animal species Recreational access	Pathogen suite @	Grab	5 sites across Reservoir	Bi-annually	Icon Water
		Pest Animal Species	Scat count Presence / absence Scent Lure LiDAR Browsing plots Combined rabbit, deer and macropod presence/absence monitoring (transect scat-counts) across the six vegetation types (natural and derived). Pig presence/absence monitoring (ripping) in Blundells Flat Carex Fen. Camera traps	Lower Cotter Catchment total and by Lower Cotter Catchment sub-catchment	Annually	Land manager, PCS
		Pathogen suite @	Grab	5 baseline + 5 additional Sites	Bi-annually	Icon Water
		Pathogen modelling	Model	Lower Cotter Catchment total and by Lower Cotter Catchment sub-catchment	Once every 5 years	Icon Water
Metals	Metal mobilisation	Metals suite*				
		Metals suite*				
		Metals modelling	Model	Across Enlarged Cotter Reservoir – spatial and depth	Once every 5 years	Icon Water
Algae	Eutrophication	Nutrients suite #				
		Cyanobacteria	Grab	5 sites across Reservoir	Seasonally	Icon Water
		Chlorophyll-a	Probe	5 sites across Reservoir	Seasonally	Icon Water
		Nutrients suite #				
		Cyanobacteria	Grab	5 baseline + 5 additional Sites	Seasonally	Icon Water
		Chlorophyll-a	Probe	5 baseline + 5 additional Sites	Seasonally	Icon Water
		Eutrophication modelling	Model	Across Enlarged Cotter Reservoir – spatial and depth	Once every 5 years	Icon Water

RISK	INDICATOR	MONITORING REQUIREMENT
* metals	Dissolved and Total: Fe, Mn, Zn, Cu, Al, As, Ba, Be, Cd, Co, Cr, Hg, Mb, Ni, Pb, Se, Au	<p>Monitor metals type and movement entering from tributaries. Metals suites generally form one analytical price. Key metals that must be monitored include Fe, Mn, Al as these particularly impact water treatment processes.</p> <p>Metals can be remobilised and impact drinking water treatment processes as well as aquatic flora and fauna.</p>
^ solids	TSS, TS, TDS, TOC, DOC, TDS	<p>Monitor sediment type and movement entering from tributaries.</p> <p>Solids can carry metals and deposit into the reservoir contributing to sediment filling the reservoir. This can impact water treatment processes if the reservoir 'turns over' and remobilises sediment and metals. This can impact water treatment processes as well as aquatic flora and fauna.</p>
# nutrients	TP, OP, TN, TKN, NH3, NOx	<p>Monitor nutrient type and form entering the reservoir from tributaries.</p> <p>Nutrients contribute to possible eutrophication of the drinking water supply. Nutrients in excess can also impact aquatic flora and fauna.</p>
@ pathogens	Total coliforms, <i>E coli</i> , <i>Enterococci</i> , Crypto, Giardia	<p>Monitor pathogen type and form entering the reservoir from tributaries.</p> <p>Pathogen type and quantity impacts drinking water treatment processes and if not eliminated can impact human health.</p>

5.6.4 MAP OF LOWER COTTER CATCHMENT MONITORING SITES

PROPOSED MONITORING SITES FOR THE LOWER COTTER CATCHMENT



106
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107

Serena Farrelly and Jack Wales. Office of the Commissioner for Sustainability and the Environment, November 2018

* Note: Sub-catchment boundaries may not represent hydrological boundaries with complete accuracy due to the modelling scale.

STAGE	LOCATIONS	COORDINATES (X,Y)
Stage 1 ▲ Implement 3 years into the 10 year plan, in line with high priority management actions	1. In Cotter Reservoir downstream of Pierses Creek confluence	148.8961, -35.3365
	2. Pieses Creek upstream of confluence with Cotter Reservoir	148.9129, -35.3350
	3. Downstream of the confluence of Lees Creek and Cotter River	148.9100, -35.3282
	4. Lees Creek upstream of the confluence with Coree Creek	148.8849, - 35.3311
	5. Coree Creek upstream of the confluence with Lees Creek	148.8878, - 35.3271
Stage 2 ▲ Implement 5 years into the 10 year plan, in line with medium priority management actions	1. Pierses Creek below large erosion gully	148.9083, -35.3492
	2. Coree Creek below commercial pine plantation	148.8800, -35.3187
	3. Coree Creek below commercial pine plantation	148.8709, -35.3151
	4. Wombat Creek below burn site	148.8398, -35.3211
	5. Condor Creek below burn site	148.8271, -35.3204
Stage 3 ▲ Implement within the life of the 10 year plan, in line with low priority management actions	1. In Cotter Reservoir upstream of Pierses Creek confluence	148.8553, -35.3100
	2. Downstream of confluence of Lees Creek and Coree Creek	148.8936, -35.3759
	3. Wombat Creek Upstream of confluence with Coree Creek	148.8818, -35.3527
	4. Reference site on Cotter River upstream of the Lower Cotter Catchment border	148.9072, -35.3355
	5. Reference site on Pierses Creek upstream of Lower Cotter Catchment border	148.8884, -35.3307

5.6.5 EVALUATING THE LOWER COTTER CATCHMENT MONITORING AND EVALUATION FRAMEWORK

In relation to the Lower Cotter Catchment Monitoring and Evaluation Framework, evaluation means both the ability to evaluate time critical data to support management objectives, but also the systematic and objective examination concerning the relevance,

effectiveness, efficiency and impact of monitoring questions and activities.

The purpose of evaluation is to discern effectiveness, isolate errors to avoid repeating them, and, ascertain evidence to support decision making and adaptive management.

Although evaluations are often retrospective, their purpose is essential for looking forward.

The evaluation component of the Lower Cotter Catchment Monitoring and Evaluation Framework is outlined in the following table:

LOWER COTTER CATCHMENT EVALUATION FRAMEWORK

FRAMEWORK	COMPONENT
Governance	<ol style="list-style-type: none">1. Lower Cotter Catchment Implementation Coordination Group (ICG) meets at least quarterly.2. Reports to the Director's-General Water Group at least annually.3. Interagency MOU on data sharing and resourcing to meet Monitoring and Evaluation Framework.4. Lower Cotter Catchment ICG commissions independent technical reviews and audits.5. Lower Cotter Catchment ICG responsible for data analysis and reporting.6. Review of the Monitoring and Evaluation Framework.
Data Management	<ol style="list-style-type: none">1. Data placed into ACT Government Data Lake.2. Coordinate and collate data and be custodian in perpetuity.3. Lower Cotter Catchment ICG responsible for ensuring all agencies inputting quality data in a timely manner.
Data Analysis	<ol style="list-style-type: none">1. Data continually analysed for trends.2. Correlations across attributes such as turbidity (NTU), rainfall, metals, solids, bare ground, other discovered aspects.3. Modelling as identified.4. Lower Cotter Catchment ICG refines data analysis protocols that support assessing impacts of activities in the catchment.5. Lower Cotter Catchment ICG refines approach to developing targets and triggers.6. Lower Cotter Catchment ICG to develop a map, showing where the listed activities operate, and the spatial sampling to address them.
Reporting	<ol style="list-style-type: none">1. 6 monthly analysis summary report compiled of key analysis findings as tables and visuals issued to key Directorates and Departments.2. Standing agenda item Director's-General Water Group, report to the Legislative Assembly in line with Reserve Management Plan 2018 statutory reporting requirements.3. Annual report with iMAP that visually shows data and outcomes on a GIS basis for community.
Review	<ol style="list-style-type: none">1. Adaptively review Monitoring and Evaluation Framework to first understand baseline during Stage 1, then Stage 2 seeks to set targets and triggers and assess land management activities. Stage 3 monitor towards restoration.2. 3 year, 5 year, 10 year intervals aligning with implementation of high, medium and low priority management actions outlined in the reserve management plan.
Data Sharing	<ol style="list-style-type: none">1. Ability held by user login to review and analyse data at any time with full access and interrogation ability.2. Open source service of Data Lake inputted data to citizens. Data may be anonymised and sanitised prior to release.

FRAMEWORK	COMPONENT
Stage 1	<ol style="list-style-type: none"> 1. Coordinate, collate and analyse all historical data from across all agencies and projects. 2. Add the data from the Stage 1 monitoring program. 3. Identify key findings and develop draft targets and triggers.
Stage 2	<ol style="list-style-type: none"> 1. Continue to coordinate, collate and analyse all data from across all agencies and projects. 2. Add the data from the Stage 2 monitoring program. 3. Identify key findings and develop final targets and triggers. 4. Assess impacts on water quality and ecological values.
Stage 3	<ol style="list-style-type: none"> 1. Continue to coordinate, collate and analyse all data from across all agencies and projects. 2. Add the data from the Stage 3 monitoring program progressively. 3. Identify key findings and validate targets and triggers. 4. Assess impacts on water quality and ecological values.

5.7 Implementation of the Framework

5.7.1 LEVERAGING SYNERGIES THROUGH ICON'S LICENCE TO TAKE WATER

Managing the Lower Cotter Catchment is a balancing act.

This monitoring and evaluation framework has been integrated to support the primary custodian, the land manager, and the water utility, Icon Water to achieve management objectives and provide data for future decision making.

Icon Water has in place an extensive routine water monitoring program to support water extraction for urban water supply and to meet requirements under their Licence to Take Water (WU67). This program includes sites in the Cotter Reservoir and two other sites upstream of the reservoir within the Lower Cotter Catchment.

To ensure consistency in monitoring and adherence to the Australian Drinking Water Guidelines, the Lower Cotter Catchment monitoring program incorporates the same suite of water quality indicators contained in the Licence to Take Water.

This report recommends that the water quality monitoring program is extended to a number of other key sites across the Lower Cotter Catchment to monitor risks to water quality before it enters the reservoir.

There are obvious synergies available which draw upon the existing processes, resources and skills in Icon Water's current monitoring in respect of their Licence to Take Water.

By incorporating the additional monitoring into Icon's Licence to Take Water routine water use monitoring program, benefits include:

- ensuring monitoring is continued for long-term analysis,

- providing Icon with clear indications of emerging risks in the catchment,
- utilising existing reporting requirements, and
- utilising existing technical expertise in water quality and ecological monitoring.

Following consultation with regulators, it is noted that amendments to the Licence to Take Water can be effected under a Regulatory Obligations Event. This can occur when a change in a regulatory obligation or requirement:

- falls within no other category of pass-through event,
- occurs during the course of the regulatory period, and
- substantially affects the manner in which Icon Water provides regulated water or sewerage services.

It is suggested that this avenue be explored for implementation.

The remaining terrestrial indicators should be implemented by EPSDD to align with management priorities outlined in the reserve management plan.

5.7.2 RECOMMENDATIONS FOR IMPLEMENTATION

1. Stage 1 water quality monitoring aspects of the framework to be incorporated into Icon Water's Licence to Take Water (WU67) through existing regulatory event mechanisms.
2. EPSDD proceed with staged implementation of remainder of framework to align with management priorities outlined in the Reserve Management Plan 2018. Where possible, the framework will support the CEMP.
3. Periodic review of the framework, at a minimum of every five years, in line with statutory reporting against the reserve management plan to government, and development of the new plan every ten years.

This relates to recommendation 1 of this report.

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Imminent Risks and Interventions



6.1 Imminent and Emerging Risks

There are many well understood risks in the Lower Cotter Catchment, as outlined in the Risk Treatment Plan.

However, there are a number of other imminent and emerging risks resulting from climate change and population growth impacts. These are less well understood and stand to compromise water quality and ecological values if not appropriately anticipated and managed.

It is important that monitoring and evaluation properly considers these risks for greater impact or effectiveness.

6.1.1 CLIMATE CHANGE

The ACT has some of the most ambitious emission reduction and renewable energy targets in the world.¹ However, this doesn't protect against the vast and unpredictable impacts of global climate change.

From floods to drought, climate change impacts are directly linked to water resources. Projections suggest south-eastern Australia will be one of the most impacted areas of the Murray-Darling Basin, with increases in surface temperatures, evaporation rates and increased water demand.²

Canberra is already at risk from increases in the severity and frequency of climate extremes.³

As a result of previous land use activities and the 2003 bushfires which completely denuded the landscape, fragmented habitat, and impaired waterways, the recovering ecosystems of the Lower Cotter Catchment are even more vulnerable to the impact of climate change.

Minimising the impact of climate change on water resources, biodiversity and other values is best achieved by building the resilience of natural ecosystems. This can be achieved through restoring native vegetation, enhancing habitat connectivity across environmental gradients and reducing the impacts of other stressors such as weeds and pest animals.⁴

CLIMATE CHANGE IMPACTS ON THE WATER CYCLE

Current drought conditions come after a 2016–17 summer characterised by record breaking temperatures, followed by a record dry winter. Rainfall over southern Australia during autumn 2018 was the second lowest on record.⁵

Climate change will have significant impacts on the water cycle, perhaps more than any other system.⁶ Current predictions suggest that the climate will become warmer and drier with the likelihood of more frequent extreme events including bushfire.

Fact box

HOW MUCH WORSE WILL EXTREME WEATHER EVENTS BECOME IN THE ACT?

The ACT can expect hotter, drier conditions as a result of climate change. But what are the projections for extreme weather events?⁷

Extreme heat:

- The number of days over 35 degrees Celsius per year is projected to increase from 7 to 12 per year by 2030
- Increasing to 29 per year by 2090

Bushfires:

- Increase in annual Forest Fire Danger Index of up to 30 per cent by 2050.

Drought:

- Increase time spent in drought, with a greater frequency of severe droughts.

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1 Office of the Commissioner for Sustainability and the Environment 2017, Implementation Status Report on Climate Change Policy

2 ACT Government 2014. ACT Water Strategy 2014–44: Striking the Balance

3 Office of the Commissioner for Sustainability and the Environment 2017, Implementation Status Report on Climate Change Policy

4 ACT Government, Lower Cotter Catchment Reserve Management Plan 2018

5 https://www.climatecouncil.org.au/wp-content/uploads/2018/06/CC_MVSA0146-Fact-Sheet-Drought_V2-FA_High-Res_Single-Pages.pdf accessed 18 October 2018

6 https://newclimateeconomy.report/2018/wp-content/uploads/sites/6/2018/09/NCE_2018_WATER.pdf accessed 15 September 2018

7 Climate Council, 2017: *Cranking Up the Intensity: Climate Change and Extreme Weather Events*

The interval between these events has also shortened, which means even ecosystems adapted to extremes and high natural variability are struggling. These changes, caused by the combined stress of climate change and extreme weather events, are overwhelming ecosystems' natural resilience.⁸

These changes are likely to result in reduced catchment yield and water quality.⁹ By 2030, climate change is predicted to cause a 10 per cent decrease in the volume of surface water available in Australia.¹⁰

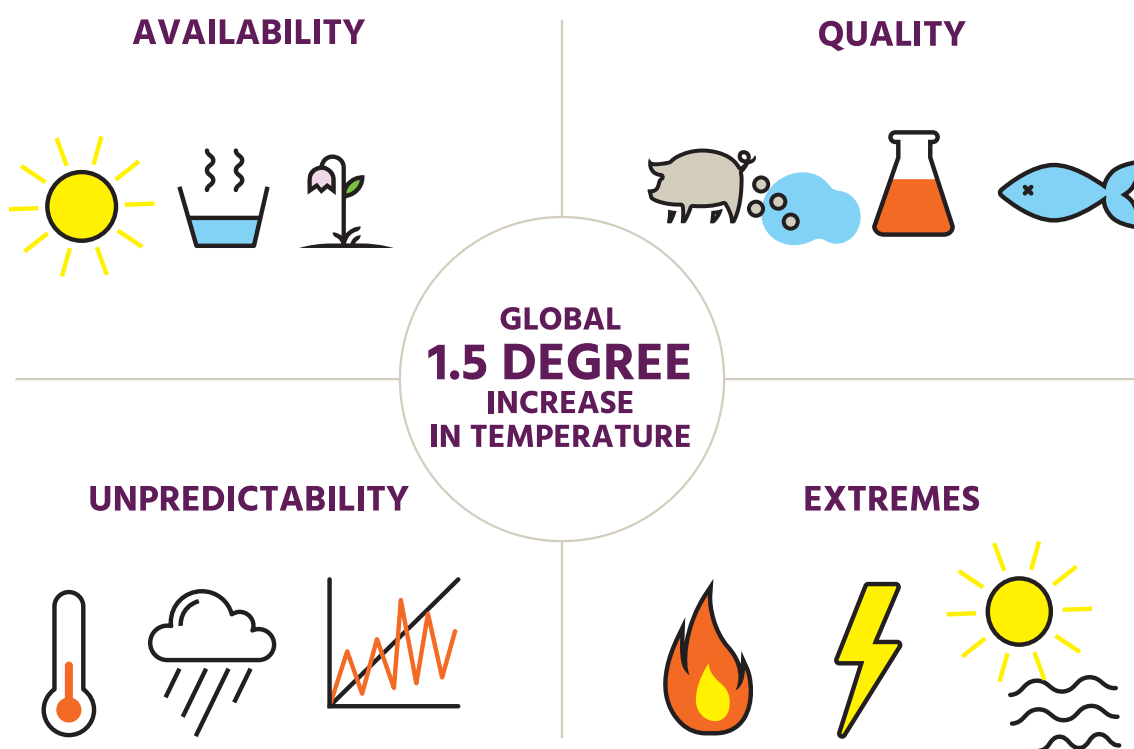
Rivers and wetland ecosystems may face the greatest pressures of any ACT ecosystem from climate change. This is due not just to water availability, but also to changing

flood regimes. Lack of flooding or flooding at the wrong time of year could lead to a cascading series of problems including increased contamination from high sediment loads or pathogens, insufficient water for fish spawning, weed invasion, and long-term changes to riparian systems.¹¹

As outlined in The New Climate Economy 2018 Report,¹² climate change impacts the water cycle primarily on four fronts:

- availability,
- quality,
- unpredictability, and
- extremes.

CLIMATE CHANGE IMPACTS ON WATER



8 <http://theconversation.com/ecosystems-across-australia-are-collapsing-under-climate-change-99367> accessed 5 July 2018

9 ACT Government 2010, Namadgi National Park Plan of Management 2010

10 <https://www.mdba.gov.au/discover-basin/landscape/climate> accessed 18 October 2018

11 ACT Government 2014. ACT Water Strategy 2014–44: Striking the Balance

12 https://newclimateeconomy.report/2018/wp-content/uploads/sites/6/2018/09/NCE_2018_WATER.pdf accessed 15 September 2018

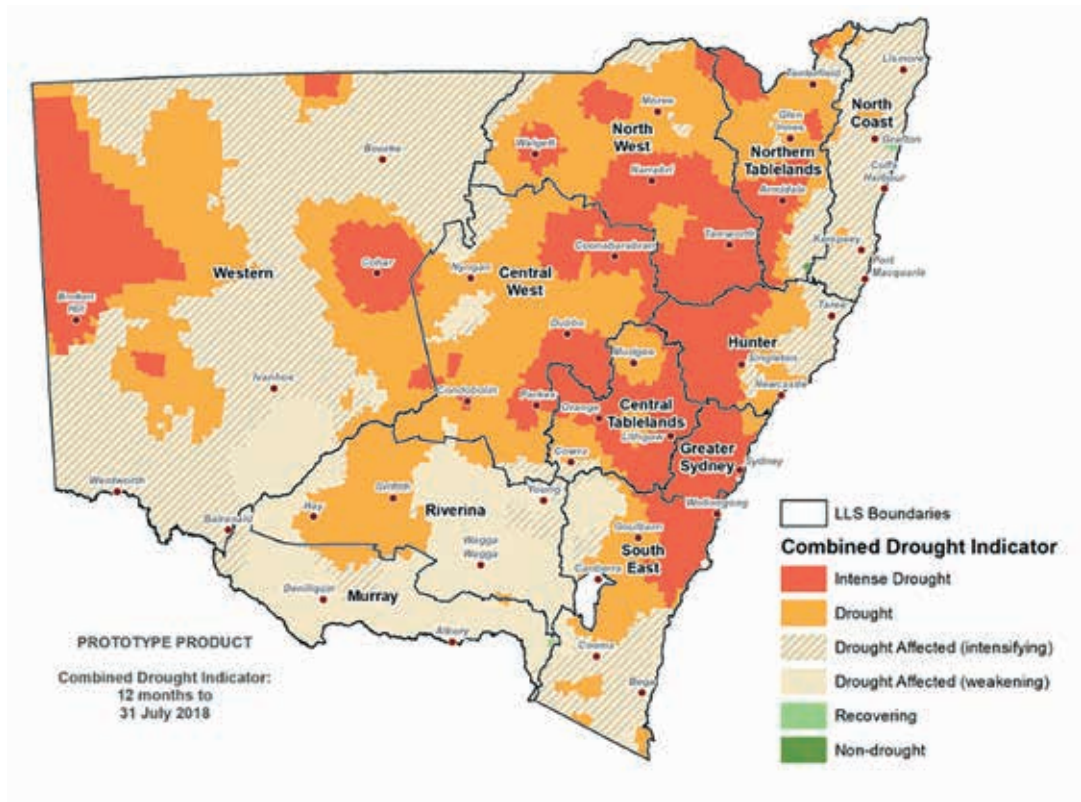
WATER PLANNING FOR CLIMATE CHANGE

Within the context of water planning and management, prolonged dry periods (droughts) are the most significant extreme event that water planners must address.¹³

While emergency management responses are in place to deal with other extreme events such as bushfires, flooding,

and heatwaves, planning for drought requires consideration of a range of short and long-term variables.

In autumn 2018, the Australian Bureau of Meteorology reported that ‘spreading dry conditions’ coinciding with a shift in the Southern Annular Mode were indicative of entering a period of prolonged drought.¹⁴ By winter 2018, 100 per cent of NSW was declared in drought.¹⁵



Source: <https://www.dpi.nsw.gov.au/climate-and-emergencies/droughthub/information-and-resources/seasonal-conditions/>

¹³ <http://www.agriculture.gov.au/water/quality/bushfires-and-water-quality> accessed 18 October 2018

¹⁴ J. Horne 2018. Resilience in major Australian cities: assessing capacity and preparedness to respond to extreme weather events. *International Journal of Water Resources Development* 34:4, pages 632-651

¹⁵ <https://www.dpi.nsw.gov.au/climate-and-emergencies/droughthub/information-and-resources/seasonal-conditions/ssu/september-2018> accessed 30 September 2018

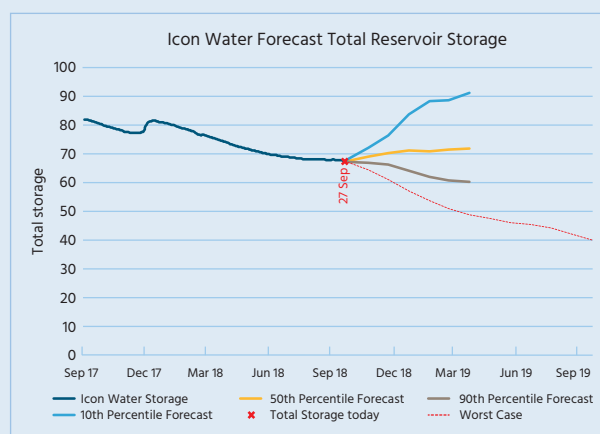
ACT WATER SECURITY MODELLING

Icon Water report that current water storage levels are sufficient to supply water to Canberra, from our present water storages, for the next 20 years, without enforcing water restrictions.¹⁶

Icon Water's operating guidelines for the source water system balance the operating cost of running the system against water security risk. A sophisticated water resources and economic model is used to find the optimal operational approach that consists of the following elements:

- estimates of the direct costs of supplying water from each source,
- estimates of the cost to the community of experiencing each level of water restrictions, and
- water resources software modelling that estimates the volumes of water supplied to and from each source, plus the frequency and severity of water restrictions under many possible future weather scenarios.

All three elements are regularly reviewed and updated. A recent forecast example is shown below.



Source: Icon Water 2018

The drawdown of Cotter Reservoir is limited from October to December to ensure that there is sufficient water for endangered fish to breed upstream.¹⁷ This approach means that Cotter Reservoir drawdown levels will continue to be dictated by climate conditions while attempting to maintain water levels suitable for aquatic ecology.¹⁸

Impacts of Water Scarcity on other Variables

Although physical changes to streamflow and run-off are well understood, water scarcity will impact variable factors such as the operations of water supply infrastructure, human water use behaviour, water quality, and environmental flow requirements.¹⁹

Abrupt changes in water availability due to drought or other extreme events may impact how these factors are realised. Water scarcity may result in a trade-off between consumptive, social and environmental uses. Therefore water plans must include measures for meeting critical human water needs during extreme events.²⁰

The ACT Government is undertaking measures such as the Water Sensitive Cities Benchmarking and Assessment and implementation of the Healthy Waterways Strategy: Striking the Balance 2014–44 to overcome these impacts by:

- reducing emissions targets,
- using water wisely,
- securing our water supplies, and
- supporting healthy rivers and wetlands.

It has never been more important that water planners and utilities clearly identify and demonstrate how climate trends and projections have been considered in developing and adapting water plans, including worst case scenarios.

16 <https://www.canberratimes.com.au/politics/act/while-one-third-nsw-in-drought-act-has-cancelled-extra-water-licence-20180619-p4zmfl.html> accessed June 24 2018

17 ACT Government EPA 2018. Licence to Take Water WU67

18 Pers. Comm., email from Icon Water, 28 June 2018

19 http://report.ipcc.ch/sr15/pdf/sr15_chapter3.pdf accessed 15 October 2018

20 <http://www.agriculture.gov.au/water/policy/nwi/climate-change>

WATER AND CLIMATE CHANGE IN THE ACT

Dr Gary Bickford, retired. Former, Director Nestis Consulting, Principal Strategic Planner, ACTEW Corporation. PhD University of Sydney.

Surprisingly there are Australian and world leaders who still do not believe that our climate is changing, or do not believe that there is any urgency to act now. Recently, a prominent federal parliamentarian informed colleagues not to be concerned about climate change, stating to an audience of about 100 that '30 years ago, the temperature was about the same globally as it is today'. For its part, the Bureau of Meteorology says all of the ten warmest years on record have happened since 1998. 2016 was the warmest, with 2015 and 2017 'effectively indistinguishable' in second place.²¹

In Australia, we know the fire season is starting earlier. Just look at what has occurred this year: the predictions are for higher temperatures, lower rainfall, more extreme temperatures and less frost for Canberra. Fortunately, here in the ACT, the government, water utilities and agencies are taking a leadership role in responding to climate change. The government has established a target of 100 per cent renewables by 2020 and net zero emissions by 2045.

About a decade ago, there was significant analysis on what effect climatic shifts would have on the water supply in Canberra. Decreasing inflows to dams, a drying catchment and higher demand for water all meant that there was a need to increase supply.

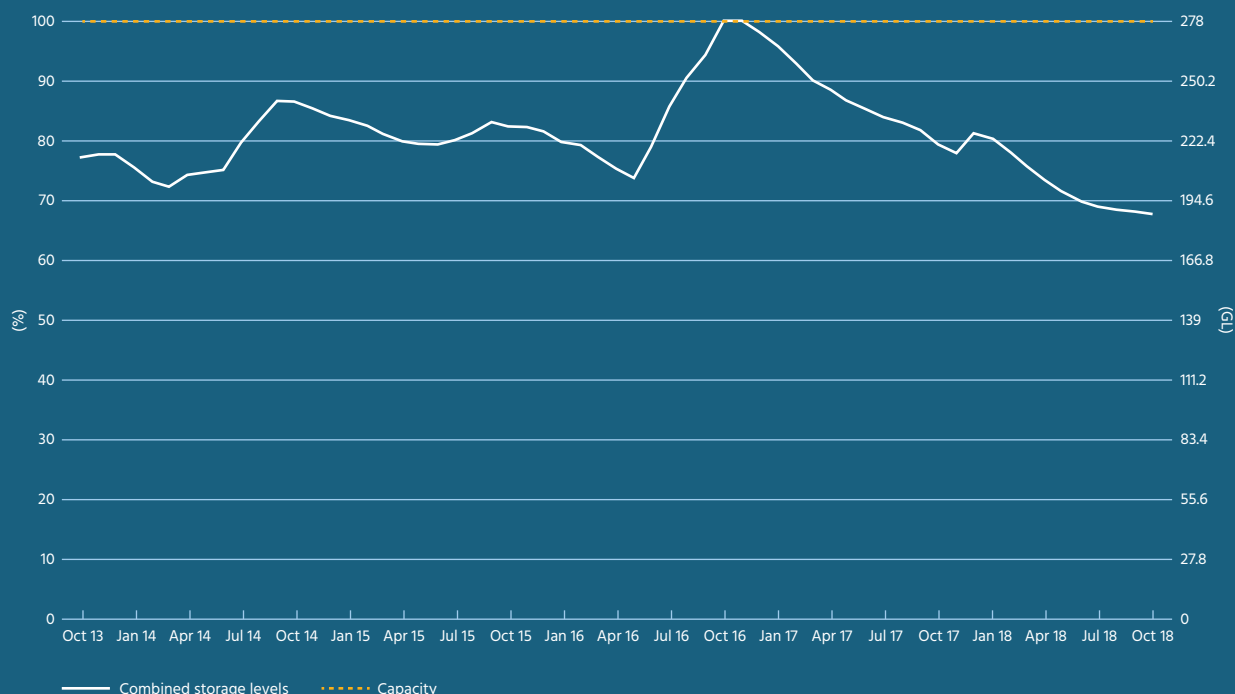
This was achieved with a range of options – notably the construction of the new Cotter Dam.

But with current storage levels in rapid decline, as is the case with many other catchments across the country, we must remain vigilant.

Each year has the potential to present new challenges and we have seen just how quickly the water situation can change. While the ACT had above average rainfall in February, much of the remainder of 2018 has been below average. We now know that the hot days in Canberra have already exceeded the earlier 2030 projections.²² We know that

'Predictions about the impact of climate change in the ACT region point to a hotter and possibly drier climate in the future. A consequent increase in fire frequency and intensity and water inflows into the Cotter catchment may be reduced by up to 50 per cent.'²³

The recent report by the Intergovernmental Panel on Climate Change, reinforces that changes 'will persist for centuries to millennia and will continue to cause further long-term changes in the climate system.'²⁴



²¹ Sydney Morning Herald accessed 4 October 2018

²² Bureau of Meteorology, 2016. State of the Climate

²³ ACT Government, Lower Cotter Catchment Reserve Management Plan 2018

²⁴ SR15, IPCC, 2018

After the new Cotter Dam was completed in 2013, it eventually filled by July 2016. But not for long; storage levels have declined quickly over the past 18 months.

This is the first time that there has been such a decline in overall storage since the new infrastructure was brought online.

While engineers have developed models to gain an understanding of how best to operate this newly configured system, such as when to pump from the Murrumbidgee River, when to release water from Corin Dam, when to pump from Cotter Dam; it is necessary to test these models against real time and worst case scenarios.

Necessarily, this will mean testing and re-testing model assumptions and refining how to respond to the different climatic factors that we encounter.

The question now to be asked is: *have the models predicted this latest fall in supply, and have responses been appropriate?*

The water industry has an exceptional track record in managing water conservation, not only in times of drought. The water industry led the way on this many years ago, but now much of that previous work has been completed.

We also need to realise that as we get better at water conservation, it gets harder to reduce water consumption during periods of drought, as customers have already made significant reductions in their daily water use.

Canberra's water use has reduced from around 500 litres per person per day in the 1970s to around 300 litres per person per day now. However, Canberra and the region's total water consumption in 2017 was 46.82 gigalitres; the highest in a decade.

While water use per person in Canberra has reduced significantly and new water supply options have been optimised, there is still a need for ongoing analysis and planning, including the possibility of future extreme events. We need to understand how customers are now using water (at 40 per cent less) and the extent to which they would be willing or able to further reduce that water use in the future, especially under a water restriction regime.

While our water supply is now quite secure,²⁵ we need to realise that change can occur very quickly and that today's climate is not like what we have experienced previously. We need to be ready to act quickly.

Scenarios such as the occurrence of a long-term drought (worse than ever experienced) coupled with a fire in the water catchment (both predicted by climate change models) need to be considered.

It is prudent to bring customers, government agencies, utility owners and stakeholders along on the journey. This is new ground in planning for new water supplies, and utilities need to ensure they are proactive in their planning and transparent in their processes. We need to be aware of global trends and position ourselves to adapt to ongoing climate extremes.

25 <https://www.iconwater.com.au/water-and-sewerage-system/water-and-sewerage-system/water-for-generations.aspx> accessed 10 September 2018

6.1.2 POPULATION GROWTH AND HEALTH RISKS

In 2015, the World Economic Forum placed water crises, defined as significant declines in water quality and quantity, at the top of its list of global risks with the greatest potential impact to society.²⁶

Further to this, the Infrastructure Australia's Reforming Urban Water Report 2018,²⁷ identifies population growth as the number one pressure influencing water supply and demand.

The ACT's population is set to reach 700,000 by 2050.²⁸ This will significantly increase water demand, and will also require a proportional increase in water and sewerage services.

While the completion of the enlarged Cotter Dam increased total water storage by 35 per cent to address water supply and demand issues, there are a host of other factors that affect human health relating to water quality.

For example, a recent population health study from the Australian National University²⁹ warns that drought affected parts of Australia have been associated with a spike in gastroenteritis cases. The study found that reported cases of the gastro bug, cryptosporidiosis, rose significantly during the Millennium Drought. A total 385 cases were reported in the ACT.

The Public Health (Drinking Water) Code of Practice 2007³⁰ lists the technical requirements for the supply, quality, monitoring and reporting on drinking water by the water utility. The code of practice requires certain events or incidents to be notified to the ACT Chief Health Officer.

Twenty notifications were made by Icon Water to ACT Health between 1 July 2014 and 30 June 2017. These related to

- blue-green algae,
- Escherichia coli (E. coli),
- chemical levels,
- turbidity, and
- potential imminent public health risks.

ACT Health has reported being satisfied that the investigations and actions taken by Icon Water were appropriate in reducing the public health risk to the ACT's drinking water supply.³¹

However, along with cryptosporidiosis, it is apparent that giardia, E.coli and other waterborne superbugs are also on the rise, associated with population growth and increased rates of global mobilisation.³²

These examples will be further exacerbated by climate change and highlight the very real risks that water quality and supply can have on public health.

The United Nations Intergovernmental Panel on Climate Change 2018 report concluded that population growth will generally have a greater effect on water resource availability than changes in climate.³³ Climate change will further exacerbate these pressures.

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26 <https://www.weforum.org/agenda/2015/01/why-world-water-crises-are-a-top-global-risk/> accessed 2 Feb 2018

27 <http://infrastructureaustralia.gov.au/policy-publications/publications/reforming-urban-water.aspx> accessed 12 October 2018

28 ACT Government 2014. ACT Water Strategy 2014–44: Striking the Balance

29 <http://www.anu.edu.au/news/all-news/big-drought-in-australia-linked-to-spike-in-gastro-cases> accessed 12 October 2018

30 Public Health (Drinking Water) Code of Practice 2007

31 <http://health.act.gov.au/datapublications/reports/chief-health-officers-report> accessed 25 September 2018

32 <https://www.canberratimes.com.au/national/act/antibiotics-not-enough-to-stop-deadly-superbugs-study-finds-20180901-p50167.html> accessed 2 September 2018

33 http://report.ipcc.ch/sr15/pdf/sr15_chapter3.pdf accessed 15 October 2018

6.1.3 BIOSECURITY – PESTS, PATHOGENS AND POLLUTION

Within the Australian geographic context, the ACT is unique in its location, size and boundaries. It is completely immersed within NSW and has no coastline, which means there are no natural barriers to biological incursions.³⁴

These differences must be taken into account and the ACT must work collaboratively with NSW to identify and address biosecurity risks.

Contaminants of most concern in water supply catchments are:

- micro-organisms (in particular organisms that are pathogenic or harmful to humans),
- suspended material (soil and organic debris),
- excess nutrients (in particular, phosphorus and nitrogen), and
- chemicals (including pesticides, herbicides and hydrocarbons).

The most common of these is contamination by human or animal excreta and the micro-organisms contained in faeces.³⁵ Feral animals carry increased quantities of dangerous pathogens that enter the supply, particularly giardia and cryptococcal bacteria, which are more transmissible to humans than those carried by native macropods such as kangaroos.³⁶

These pest species can also impact suspended material and excess nutrients in the water supply. Their hard hooves and propensity to wallow in riparian zones mobilises sediment

and faecal matter into the water supply which can incite algal bloom events from nutrient fluxes.³⁷

As well as direct water quality effects, management of the numbers of native and feral animals is important in terms of grazing pressure and loss of ground cover. Overgrazing by kangaroos and soil disturbance from feral animals, such as pigs and deer, can expose soils to erosion and cause a loss of biodiversity.

Preventing feral fish species such as Carp and Redfin Perch from entering the system is just as crucial, both for improving turbidity and safeguarding native fish. For example, Carp stir up mud on banks while gathering food and Redfin are a carrier for the epizootic haematopoietic necrosis (EHN) virus, to which the endangered Macquarie Perch suffers a 100 per cent mortality rate.

All of these risks have complex cross-border implications and ongoing management plans with NSW are in place for a variety of species. However, these management plans and relevant legalisation can be influenced by political motivations where the ACT stands to lose out.

A recent example of this is the *Kosciuszko Wild Horse Heritage Bill 2018*³⁸ and associated Draft Wild Horse Heritage Plan³⁹ curtailing brumby culling.

Management actions relating to biosecurity risks in the reserve management plan are limited to managing recreational activity. With greater threats from existing and emerging pests, particularly under climate change conditions which favour these species, serious consideration needs to be given to managing as a direct biosecurity action.

“Land will manage itself, we need to manage people and their impact on the land.”

Land manager, Parks and Conservation Service.

34 ACT Government Biosecurity Strategy 2016-2026

35 Australian Drinking Water Guidelines 2011

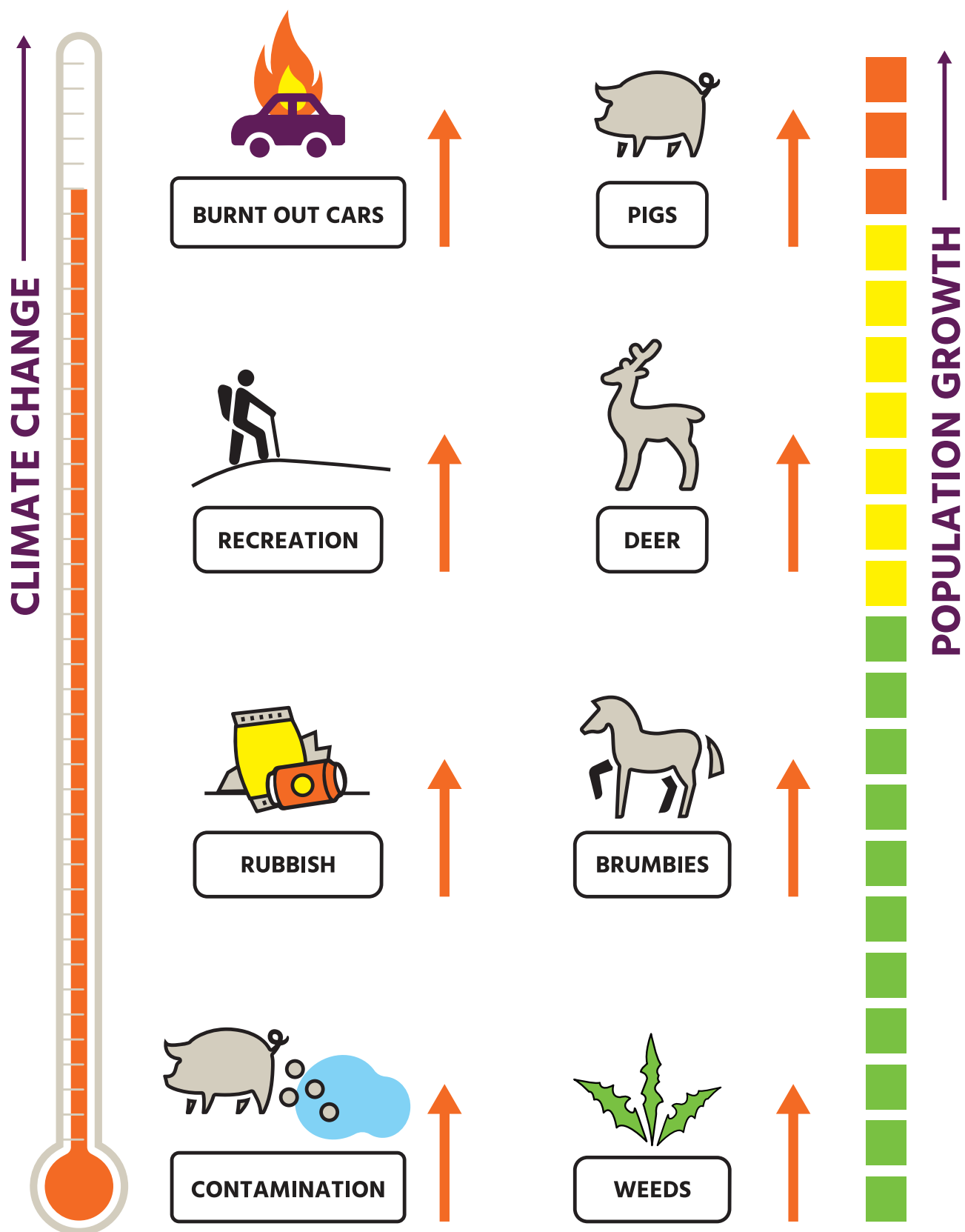
36 Vermeulen, E., Ashworth, D., Eldridge, M. & M. Power 2015. Investigation into potential transmission sources of *Giardia duodenalis* in a threatened marsupial (*Petrogale penicillata*), *Infection, Genetics and Evolution*. Volume 33, 2015.

37 Howarth, R., Anderson, D., Cloern, J., Elfring, C., Hopkinson, C., Lapointe, B. & D. Walker 2000. Issues in ecology: Nutrient pollution of coastal rivers, bays, and seas

38 *Kosciuszko Wild Horse Heritage Bill 2018*

39 <https://www.environment.nsw.gov.au/resources/protectsnowies/knp-wild-horse-plan-draft-160271.pdf> accessed October 23 2018

IMMINENT RISKS IN THE LOWER COTTER CATCHMENT



BURNOUTS IN THE BUSH



Burnt out car near Condor Creek. Source: Caitlin Roy



Pierces Creek bushfire. Source: Brendan Smith

The Lower Cotter Catchment is one of the ACT's reserves used for recreation, with many associated health benefits.

When considering recreation in and around our surrounding waterways and nature reserves, fishing, camping, or mountain biking might spring to mind. However, one of the more damaging uses of the Lower Cotter Catchment is the dumping and subsequent burning of cars. This is an illegal activity.

From 2014–17 there have been over 100 car related ignitions in and around the Lower Cotter Catchment,⁴⁰ bringing with them immeasurable financial and environmental costs.

Most notably, the Pierces Creek fire of November 2018, which ignited from a burning car just south of the Lower Cotter Catchment, and only seven kilometres from the nearby residential suburb of Kambah.

The blaze burned out of control for several days, damaging over 200 hectares of the Pierces Creek Forest and resetting the landscape to post 2003 conditions.

As reported by ABC News, ACT Emergency Services and Parks and Conservation Service Rangers have a growing concern about the potential for abandoned cars to cause risk to the community,

***"The risk that it places on the Canberra community, particularly coming into the [fire] season we're about to face, is a very real risk."*⁴¹**

***"When anyone burns a car, there's a potential for it to spread into a plantation and if it's a bad fire day, the potential for it is to turn into a catastrophic event depending on weather conditions."*⁴²**

Emerging research from the University of Melbourne indicates that there is a clear pattern between arson occurring and accessibility by road or track.⁴³ For the Lower Cotter Catchment with its close proximity to residential areas and over 300 kilometres of

40 Pers. Comm., email from Parks and Conservation Service, 28 June 2018

41 <https://www.abc.net.au/news/2018-11-05/canberra-fire-burnt-car-parks-rangers/10465530> accessed 5 November 2018

42 <http://www.latrobevalleyexpress.com.au/story/4945140/dumped-car-fire-risk/> accessed 18 June 2018

43 Pers. Comm., email from University of Melbourne, 24 July 2018

accessible roading network, this could go some way to explaining why it is a hot spot for dumping and burning cars.

The *Road Transport (Safety and Traffic Management) Act 1999*⁴⁴ actually precludes the immediate removal of abandoned cars by government authorities.

Once a vehicle is deemed abandoned, authorised personnel put a sticker on the windscreen directing the owner to move it within two days. If the abandoned vehicle is not removed within that time it will be organised for collection and impoundment at the ACT Government retention facility.⁴⁵

In the face of this regulatory impasse, ACT Policing, ACT Parks and Transport Canberra and City Services work together to deal with the problem, running stolen vehicle checks, and collaborating in arranging removal and storage.⁴⁶

Parks and Conservation Service staff and other regional councils have identified that the time lag between vehicle dumping and enforceable removal is when arson is most likely to occur. Consequently, some regional councils are seeking legislative intervention for the immediate removal of abandoned vehicles.⁴⁷

The specific risks associated with burnt out cars in the Lower Cotter Catchment indicate that further

reform is needed to ensure the timely removal of abandoned vehicles.

While government may incur some up-front costs by amending the legislation to allow the timely impoundment of abandoned vehicles by ACT authorities, the benefits of supporting such intervention are clear. These benefits include:

- reduced risk of arson,
- reduced risk of subsequent uncontrolled bushfires,
- avoided or reduced cost to catchment recovery initiatives,
- avoided adverse impacts to water quality and water security,
- reduced bushfire risk to the national park and residential areas, and
- reduced risk to public safety.

The sheer number of arson-burnouts in the catchment invites the conclusion that it is only a matter of time before some or all of these risks eventuate, notwithstanding the efforts of the services involved in mitigating the impacts of this criminal and foolhardy activity.

Refer to recommendation 5 of this report.

44 *Road Transport (Safety and Traffic Management) Act 1999*

45 Canberra Times article: <http://www.abc.net.au/news/2016-11-24/more-than-500-cars-abandoned-on-act-roadsides-last-year/8035048> accessed 10 May 2018

46 <http://www.abc.net.au/news/2016-11-24/more-than-500-cars-abandoned-on-act-roadsides-last-year/8035048> accessed 10 May 2018

47 <https://www.cessnockadvertiser.com.au/story/4968117/dumped-cars-a-nightmare/> accessed 10 May 2018

6.1.4 PEST PLANT AND ANIMAL SPECIES

With population growth and climate change comes an increased threat of pest plant and animal species, particularly via waterways and in reserves close to human settlements such as the Lower Cotter Catchment. These pests can be transmitted by humans directly or take advantage of human land use activities such as roading networks, increasing their distribution patterns and home ranges.

In the wake of the 2003 bushfires, habitat destruction allowed for exotic plant species such as blackberry to colonise empty niches, while native grazers and feral species such as rabbits, pigs and foxes were able to take advantage of these newly opened corridors.

Weeds are prolific in many areas of the catchment. Large patches of blackberry and St Johns Wort occur in the former pine plantation areas, increasing numbers of pine wildlings will continue to maintain a stranglehold while commercial pine plantations are present.

Pest plants and animals are an input into the natural system, and often have a bigger impact than native species in influencing catchment conditions. Their potentially increasing presence in the Lower Cotter Catchment is cause for alarm. Increasing community engagement and citizen science activities is one way to combat the vast spread and damaging impacts of these pest species, with innovative methods of displaying this information emerging all the time.

Case Study

CANBERRA NATURE MAP ([HTTPS://CANBERRA.NATUREMAPR.ORG/](https://canberra.naturemapr.org/))

The Canberra Nature Map is an interactive online mapping tool for the community to both learn from and contribute information on the flora and fauna of the Canberra region, as well as promote its value.

Since its inception that there have been over 20 listings for flora and fauna in the Lower Cotter Catchment. Some of these listings have helped identify rare native species or emerging exotic species that can be subsequently managed by the Parks and Conservation Service.

In this regard, the nature map has tremendous value for land management purposes as well as building community custodianship of environmental assets.

As citizen science in action, it shows the value of a volunteer local website run by local people with local knowledge as part of a strong interactive community.



Trigger plant (Stylidium graminifolium). Source: Ian Falconer



Twining fringed lily (Thysanotus patersonii). Source: Ian Falconer

6.1.5 VULNERABLE ALPINE ECOSYSTEMS

The Lower Cotter Catchment is bound to the south and west by Namadgi National Park and represents the northernmost end of a string of protected areas covering more than 1.6 million hectares. This area, known as the Australian Alps National Parks, includes Namadgi National Park in the ACT, Kosciuszko National Park in NSW and the Victorian Alpine National Park.

The sub-alpine areas of the ACT are among the most pristine in Australia.

With the passing of the *Cotter River Act* in 1914 and the subsequent establishment of Namadgi National Park in 1984, these pristine areas have been legally protected as a catchment and have served as an environmental refuge for over a century.

These sub-alpine areas, including the Ramsar listed Ginini Flats and numerous other smaller peatlands, provide precious ecosystems that collect and filter water into the Cotter River.

The north west corner of the Lower Cotter Catchment contains two small wetland communities at Blundells Flat and Shannons Flat. These ecological communities are categorised as Alpine Sphagnum Bogs and Associated Fens and are listed as endangered under the *Environment Protection and Biodiversity Conservation Act 1999*. This is due to its small geographic distribution, coupled with significant demonstrable threats including climate change and fire.

Native species will likely experience quite different local environments than they do now and will need to adapt to those environmental changes; either expand or change their range, or go extinct. Species with restricted climatic ranges, small populations, or limited ability to adapt or migrate, are most likely to suffer dramatic declines or local extinction as suitable habitat disappears in the ACT.

With deer already pushing into the catchment and the growing threat of feral horses crossing the border, it is critical to continue to protect these valuable assets against the damaging impact of hard hoofed animals.

“These vulnerable ecosystems can take decades and even centuries to recover from disturbance. As we have seen from the impact of large scale grazing in both NSW and Victoria, it is much easier and far cheaper to preserve existing alpine and sub-alpine ecosystems than to rehabilitate them.”

John McRae, Program Manager, Australian Alps National Parks Cooperative Management Program.

122

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123



Ginini Flats site visit October 2018. Source: Caitlin Roy

BRUMBIES AND DEER LOOM NEAR

Wild horses (brumbies) have populated Australia's high country since the 1890s pastoral era. Deer are an emerging problem of similar dimensions.

Growing in population, brumbies have a significant impact on the environment. These impacts are especially severe in alpine and sub-alpine regions given the short growing season, restricted range of native vegetation, and fragility of soils.

For over 100 years actions have been taken by government and landowners to protect the Cotter Catchment from the impact of wild horses.

'Brumby running' has been the preferred management technique within the ACT, corralling stray horses into purpose built yards and either domesticating or euthanising them.

Today, with remote sensing cameras and helicopter surveillance, ACT Parks and Conservation Service monitor for any incursions, acting quickly to remove brumbies when they are detected in the jurisdiction.⁴⁸

Brett McNamara from ACT Parks and Conservation Service comments:

"[We] have been effective in excluding horses moving from Kosciuszko into the ACT's high country. But a threat looms on the horizon to our west. Thousands of feral horses roam free and don't recognise state borders. We will have a strong interest in whatever control programs NSW adopt, as they have to be effective enough to ensure the ACT's water catchment is not impacted by horses crossing the border."⁴⁹

The brumby issue is now being compounded by a rise in the population of feral deer. The majority of sightings of deer have occurred in the Cotter Catchment and Namadgi National Park. A recent ANU research report on the activity of pest deer species has concluded that deer actually prefer to inhabit areas of high ecological value, such as riparian areas.⁵⁰

The impacts of deer include:

- changing forest composition and structure through selective browsing and wallowing,⁵¹
- soil compaction,
- erosion,
- trampling vegetation,
- ringbarking,
- damaging 'bog' habitat and waterholes,
- spreading invasive weeds, and
- detrimental effects to native flora and fauna.

Feral deer are a declared pest animal in the ACT under the provisions of the *Pest Plants and Animals Act 2005* and similar to brumbies, management strategies for deer also vary between Australian States and Territories.

In neighbouring NSW and Victoria, deer are classified as a game species rather than a pest,⁵² affording them a form of protection. Licences for hunting are enforced, however private property owners can manage and control deer populations on private land and are not subject to these requirements.

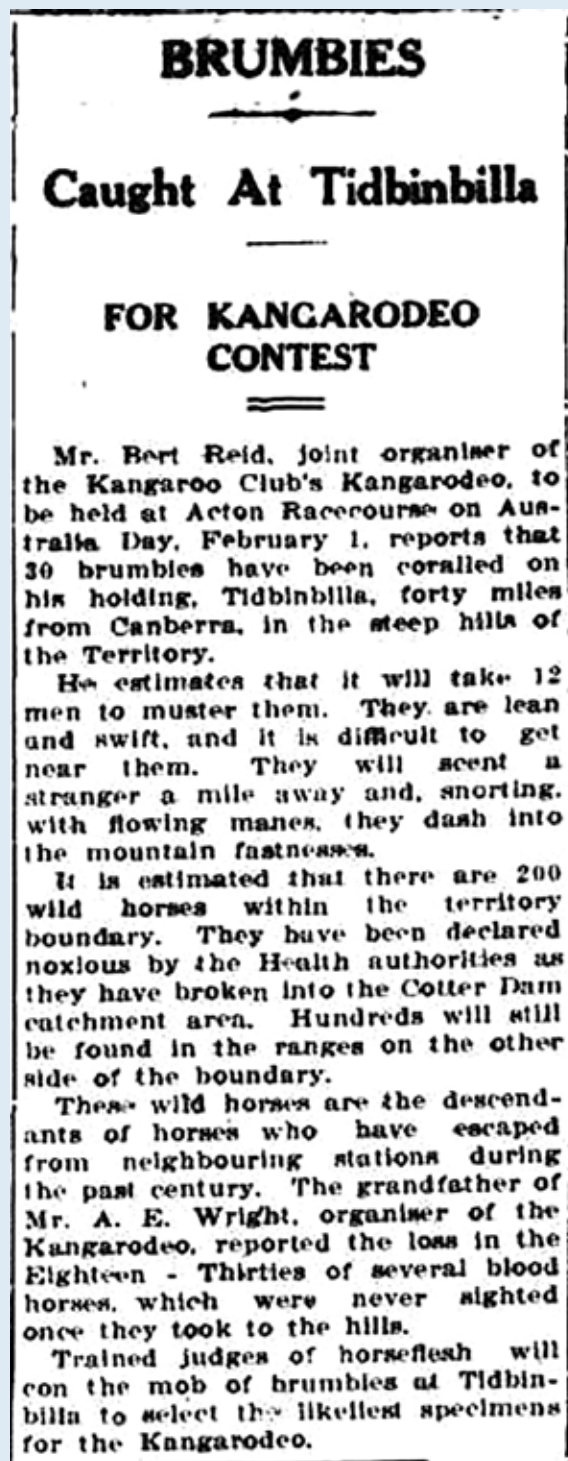
48 <https://www.environment.act.gov.au/home/Bush-Capital/a-catchment-worth-protecting> accessed 20 June 2018

49 <https://www.queanbeyanagechronicle.com.au/story/5469654/drag-the-wild-horses-away/?cs=1907> accessed 19 June 2018, <http://citynews.com.au/2018/feral-horses-threaten-act-drinking-water/> accessed 8 June 2018

50 Hosking, G. 2016. Investigating Deer Habitat Use by Indirect Methods, in South-East Australia: A Pilot Study. Australian National University undergraduate research project.

51 Monitoring Impacts of Sambar Deer, https://www.environment.act.gov.au/__data/assets/pdf_file/0003/1149015/Technical-report-MONITORING-IMPACTS-OF-SAMBAR-DEER-October-2017.pdf accessed 8 June 2018

52 Davis, N., Bennett, A., Forsyth, D., Bowman D., Lefroy, E., Wood, S., Woolnough, A., West, P., Hampton, J. & C. Johnson 2016. A systematic review of the impacts and management of introduced deer (family Cervidae) in Australia. *Wildlife Research*, 43, 515-532



The Canberra Times, Tuesday 19 January 1932. Source: National Library of Australia

There are currently no techniques available for broad scale control of feral deer populations and localised control of feral deer is limited to opportunistic ground based shooting.

In the broader community, brumbies and deer are often perceived as beautiful animals holding sentimental value and therefore shouldn't be culled, controlled or managed.⁵³ However as Professor David Watson, an ecology expert at Charles Sturt University and former member of the NSW Threatened Species Committee, points out, **'put simply, feral horses are incompatible with protected area management.'**⁵⁴

This can be said for all hard-hoofed feral species roaming the ACT. With the threat of climate change and expanding ranges of these feral species, targeted cross-border management strategies need to be rigorously administered to protect environmental values and the ACT's pristine water supply.

124

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125

53 Burgin, S., Mattila, M., McPhee, D. & T. Hundloe 2015. Feral deer in the suburbs: An emerging issue for Australia? *Human Dimensions of Wildlife*, 20, 65-80

54 Canberra Weekly 21 June 2018 edition accessed 25 June 2018

6.2 Interventions

6.2.1 BUILDING ECOSYSTEM RESILIENCE

Ecosystem resilience is the capacity of a system to absorb disturbance and reorganise while still retaining similar function, structure, and feedback loops. This includes ecosystem processes such as primary production, nutrient cycling, decomposition, transpiration and emergent properties such as competition and resilience.⁵⁵

As outlined in the ACT State of the Environment Report 2015,⁵⁶ a resilient water supply network in the ACT would mean that Lower Cotter Catchment values are maintained or improved despite major disturbances.

For example, threats such as fire, drought, loss of vegetation cover and erosion are reasonably well known, whereas knowledge of other emerging threats are less well understood. There is also growing recognition of the need to understand landscape and regional-scale threats and relative trade-offs.⁵⁷

As well as recognising the pressures, resilience also relies on monitoring to ensure that the impacts of system pressures are identified and corrected promptly. Currently there are large gaps in existing monitoring of ecological restoration and water quality, particularly monitoring of the processes that cause changes to water quality, such as sediment mobilisation. This affects the ability to predict when a threshold is being approached, and therefore at which point water quality may be threatened.

Implementation of an integrated water quality and ecological monitoring and evaluation framework with the ability to adapt over time is critical for developing ecosystem resilience to protect valuable ecological assets against future disturbances.

6.2.2 EMERGING TECHNOLOGIES

The use of drone technology has been steadily expanding across the environmental management sector, from spraying weeds through to monitoring, surveying and mapping.

Some of the benefits include:

- having a wide range of management functions,
- being lightweight,
- low-cost, requiring little to no infrastructure, and
- crucially, no fuel.

More traditional methods used for mapping, such as satellites, have low resolution and less frequent sampling. Conversely, ground-based sensors can record information from a fixed geographic location continuously, however a drone-based sensor records a fixed point in time over a wider geographical range.⁵⁸

In the Lower Cotter Catchment, ACT Parks and Conservation Service is already utilising drones to wage war against blackberry and pine wildlings.⁵⁹

Rangers use everything from amphibious vessels, canoes and abseiling to take the fight to the weed enemy and there's a niche market for this machine in steep, wet, inaccessible areas where spraying can't be done with conventional methods.

The ACT Government spends \$2 million each year on weed control. In the Lower Cotter Catchment area alone, hundreds of thousands of dollars have been spent just to fight blackberry and other weeds.⁶⁰

Another example of the use of drones is their capacity to geospatially quantify the range and damage of brumbies. A recent study funded by the Australian Alps Liaison Committee presents an approach for modelling based on drone surveys and high-resolution digital images that enable year to year comparisons to assess rates of stream degradation from brumby incursions.⁶¹

While these new technologies come with up-front costs, as well as safety and security risks, the potential to assist in the understanding and management of large and inaccessible areas is immense.

55 http://seraustlasia.com/wheel/image/SER_International_Standards.pdf accessed 18 September 2018

56 <http://reports.envcomm.act.gov.au/actsoe2015/the-report/6-water/index.html> accessed 18 September 2018

57 <http://reports.envcomm.act.gov.au/actsoe2015/the-report/6-water/index.html> accessed 18 September 2018

58 www.researchgate.net/publication/313840447_Drone_Applications_for_Environmental_Management_in_Urban_Spaces_A_Review accessed 15 October 2018

59 www.abc.net.au/news/2015-03-01/drones-used-to-wage-war-on-blackberry-brambles-near-canberra/6126334 accessed 12 May 2018

60 www.abc.net.au/news/2015-03-01/drones-used-to-wage-war-on-blackberry-brambles-near-canberra/6126334 accessed 12 May 2018

61 Seminar by Dr David Paull, UNSW Canberra - Unmanned Aerial Vehicles to Measure and Monitor Streambank Impacts of Wild Horses in the Australian Alps



Blackberry sprayed by drones (purple area) near Cotter Reservoir. Source: Adrienne Francis, ABC News

6.2.3 MODELLING AND MAPPING

Through the course of this evaluation it has been observed that there is a lack of high quality modelling and mapping available for the Lower Cotter Catchment.

Information from land restoration should be summarised where possible in map form to show where management issues change over the site. This will help form the basis of appropriate units for management and locations for monitoring.⁶²

There are several examples to illustrate this, such as:

- Aerial imagery of the Lower Cotter Catchment is not readily available pre and post 2003 bushfires. This would have allowed better reflection of progress over time for restoration efforts.
- The sub-catchments of the Lower Cotter Catchment have not been accurately mapped to hydrogeological boundaries for Pierces Creek, Lees Creek and Condor Creek. Given the different nature of these sub-catchments it would seem valuable to have these mapped.
- Modelling of climate change impacts on water has not been updated since 2014. Given recent trends for new extremes in high temperatures, this appears to be outdated.
- Maps were not readily available for land management activities such as broad scale pine wildling management, prioritisation of erosion works planned and undertaken, and roads connected to waterways.

- Outcomes of hazard reduction burns are not clearly modelled or mapped. This makes it difficult to ascertain the effectiveness of this important activity and demonstrate ongoing adaptive management.

The ability to conceptualise and observe the implications of various restoration efforts will remain necessary for many years. Effective modelling can assist in analysing different scenarios both in time and extent to support business case development and prioritisation of investment. Meaningful mapping not only provides an important communication medium, but also can be used to assess management outcomes over time.

Aerial photography is now commonly used to gain an overview of the features at a site. Observation through stereo-pairs of aerial photographs can help give an even better understanding of topography, landform, presence of vegetation and man-made features for very large-scale sites prior to commencing fieldwork.

The value of modelling and mapping will assist in ensuring important elements of restoration are achieved including:

- reduction in erosion,
- reduction in invasive species,
- improvement in habitat quality and connectivity, and
- reduction in fire hazard.

This relates to recommendation 1 of this report.

126
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127

62 Government of South Australia 2010. Habitat Restoration Planning Guide for Natural Resource Managers

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Conclusions and Recommendations



7.1 Report Conclusions

It is inevitable that fire and drying conditions will continue to affect the Lower Cotter Catchment at varying scales, as they have for millennia. In fact, the Lower Cotter Catchment has already withstood several cases of controlled and uncontrolled burning since 2003 with minimal impacts to revegetation and restoration efforts.

The known historical pattern of fire in the Lower Cotter Catchment is likely to be entering a new phase, with the introduction of a regime of regular planned fires to create advantages in protecting the catchment from bushfires.

The question that remains is whether enough is being done to build resilience in the landscape and water supply to protect the community from the next big fire event.

POSITIVES

Flowing through every part of our economy, water is a fundamental necessity for lives and livelihoods. Access to safe, sufficient water and sanitation, and sound management of freshwater ecosystems is essential to economic prosperity, public health, and to environmental sustainability.¹

The range of evidence gathered in this evaluation highlights the positive influence restoration works and land management activities are having on the recovering landscape of the Lower Cotter Catchment.

This is an important story and one well-founded on available information. However, there are parts of the story still missing.

CHALLENGES

This evaluation has also revealed significant gaps in the data.

This means that while we can make assessments about land use impacts, we are not able to report in a qualitative, measurable way on the suite of indicators required to accurately inform risk and decision making.

Without consistent and targeted data we cannot fully understand the extent of pressures, the rate of change, or how emergent land use practices, including recreation activities, are likely to impact water quality and ecological values.

Overcoming this fundamental knowledge gap is not an easy task. It will require many different parties to work together to source data, resolve data ownership issues, and to target investment.

Implementation of the Lower Cotter Catchment Monitoring and Evaluation Framework is the first step in this process.

128

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129

¹ https://newclimateeconomy.report/2018/wp-content/uploads/sites/6/2018/09/NCE_2018_WATER.pdf accessed 15 September 2018

7.2 Recommendations

RECOMMENDATION 1: MONITORING AND EVALUATION IMPLEMENTATION

You can't manage what you can't measure.

Upon commencing this restoration evaluation it became apparent early on that since 2003 there have been very few consistent data sets monitoring water quality, ecological restoration or management activities in the Lower Cotter Catchment.

Monitoring and evaluation is critical to inform ongoing operations, improve policy and strengthen accountability by tracking the effective use of resources.

To address this critical gap and better support effective catchment management, this office has developed an **integrated water quality and ecological monitoring and evaluation framework**. When implemented, this framework will provide consistent and targeted data to monitor key risks and measure outcomes of actions outlined in the Reserve Management Plan 2018 to inform ongoing adaptive management.

1.1 The Lower Cotter Catchment Monitoring and Evaluation Framework be implemented urgently.

- **Stage 1 water quality monitoring aspects of the framework to be incorporated into Icon Water's Licence to Take Water (WU67) through existing regulatory event mechanisms.**
- **EPSDD proceed with staged implementation of the remainder of the framework to align with management priorities outlined in the Reserve Management Plan 2018. Where possible, the framework will support the Conservation Effectiveness Monitoring Program.**
- **Periodic review of the monitoring program every five years in line with statutory reporting against the Reserve Management Plan to ACT Government and development of the new plan every ten years.**

Although there has been some activity-based and research monitoring through the years in the catchment, data are not visible or accessible. This prohibits the ability to efficiently analyse and build upon existing information. For a long-term restoration project of this nature, it is essential that data are centralised and made available for internal operations and external scrutiny.

1.2 All existing and future Lower Cotter Catchment data should be stored in a secure central database.

- **Prioritised water data should feed into the Chief Digital Officer's data lake.**
- **All other government project, activity-based, ecological data should feed into a central database for access by internal government stakeholders.**
- **Make Lower Cotter Catchment data open access data for research, education and community use. Universities and community groups can also feed data into this repository.**

Various critical gaps relating to modelling and mapping have been observed through the course of this evaluation. For example, there was no aerial imagery available of the catchment post 2003 bushfires, the closest being 2009, and the most recent LiDAR available is from 2015. Another observation is that climate change projections factored into water security planning have not been updated since 2014. Given that we have been experiencing consecutive years of extreme weather conditions, likely linked to climate change, this would appear to be too long of a period between updates, compromising the accuracy of water security modelling.

1.3 Improve consistency and coordination of monitoring, mapping and modelling resources across government, including:

- **Update climate change projections for water supply modelling. Ensure they are updated every three years, and modelling should include worst case scenarios.**
- **Ensure aerial imagery and LiDAR data are collected every two years.**
- **Address critical gaps in mapping of restoration efforts such as weed management, erosion works and pine wildling control.**

RECOMMENDATION 2: FUNDING AND RESOURCES COMMITMENT

Putting a price on long-term water security.

The one off amount of \$7.9 million allocated to fund restoration activities in the Lower Cotter Catchment following the Auditor-General's 2015 Report has all but dried up.

While there is a nominal amount of recurrent funding allocated to core business (managing pests, weeds, erosion control, fire fuel reduction, roading network, recreation), this is not enough to maintain ongoing restoration works or any additional works.

Climate change, population growth and imminent drought conditions are increasing the risk to catchment values, and this is occurring while funding and resourcing dwindle.

Budget bids and the formal budget process to win, even small amounts, of funding have proven unsuccessful and time consuming. This diverts the valuable time of land managers away from their core operational responsibilities and increases the risk to water quality and ecological values. In addition, currently and for the foreseeable future, there is a significant policy and strategic demand placed on the land manager in relation to the statutory implementation of the Reserve Management Plan 2018.

Adequate recurrent funding and strategic one-off funding must be institutionalised to put the right price on the value of the Lower Cotter Catchment in securing Canberra's long-term water supply. The restoration of this reserve will take decades and mitigating the fire hazard risk will be required in perpetuity.

- 2.1 Allocate discrete annual funding from the Water Abstraction Charge directly to catchment management for the life of the Reserve Management Plan 2018. This is in addition to existing recurrent funding. Financial year budget rollover is necessary to reflect the contract management cycles for land management works.**
- 2.2 Distribute Parks and Conservation Service (PCS) funding discretely for core ongoing operational and strategic long-term management. Allocation of resources between business units within PCS should reflect reserve management responsibilities outlined in the implementation plan.**
- 2.3 Allocate funding specifically for the implementation and ongoing costs of Recommendation 1 (Monitoring and Evaluation Implementation) across PCS, Conservation Research, Water Policy, and the Environment Protection Authority respective of their individual contributions.**

130

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131

RECOMMENDATION 3: GOVERNANCE IMPROVEMENTS

Good governance is working towards common goals.

The Auditor-General's Report No.3/2015 made twelve recommendations; eight of these twelve recommendations were either totally or in part related to matters of governance.

As part of the restoration evaluation, this office undertook a review of the implementation status of these recommendations. This was an exercise firstly to ensure accountability of government commitments, and secondly to ensure that appropriate mechanisms and structures were in place and functioning successfully to ensure capacity to move on to the next phase of management actions outlined in the Reserve Management Plan 2018.

While there is no argument that an enormous volume of work has been carried out to complete all twelve recommendations of the Auditor-General's Report, and to meet legislative requirements for the planning and implementation of the Reserve Management Plan 2018, this review identified a number of concerns.

The following recommendations have been formulated to address these concerns.

- 3.1 Complete outstanding Auditor-General's recommendations, specifically recommendations 1, 3 and 4, as a matter of priority by no later than 30 June 2019. This includes undertaking an internal review to confirm completion of all recommendations in consideration of observations made in this report.**
- 3.2 Review and update the Lower Cotter Catchment Risk Treatment Plan quarterly as per ACT Insurance Authority requirements. Include risk management as a standing item on the Lower Cotter Catchment Implementation Coordination Group meeting agenda.**
- 3.3 Develop the Reserve Management Plan 2018 Implementation Plan as outlined in the plan and under the *Nature Conservation Act 2014* by no later than 30 June 2019. This should include the strategic long-term management of commercial pine plantations, non-commercial pine plantations, and pine wildling regrowth.**

RECOMMENDATION 4: COORDINATION OF EFFORTS

Coordination is working towards common goals together.

The Lower Cotter Catchment has a range of stakeholders across all levels of government and sectors of the community.

Primary management of this catchment is attributed to Parks and Conservation Service, while working closely with Icon Water, Environment Protection Authority, Emergency Services Agency, Water Policy, Conservation Research, universities, catchment groups, and the broader community.

The Lower Cotter Catchment Implementation Coordination Group was developed to implement the Auditor-General's recommendations and, following completion of these, to form an operational working group.

Effective collaboration within this group is critical to achieving management outcomes and elevating the importance of the Lower Cotter Catchment in securing Canberra's long-term water supply.

- 4.1 Review the Terms of Reference for the Lower Cotter Catchment Implementation Coordination Group, including relevant attendees, and revert to 'Phase 1' until all high and medium priority management actions outlined in the Reserve Management Plan 2018 are complete. This Group will then be critical to review and assess the Lower Cotter Catchment Monitoring and Evaluation Framework at set intervals over time to facilitate adaptive management.**
- 4.2 The Lower Cotter Catchment be placed as a standing agenda item on the Director's-General Water Group meeting for the life of the current Reserve Management Plan 2018. The Implementation Coordination Group Chair or a delegate should report to the meeting.**
- 4.3 The Lower Cotter Catchment become a standing agenda item on the Regional Catchment Management Group meeting schedule, to ensure the consideration of matters concerning water security, climate change, bushfire management, water quality, and feral species, at a regional level.**

132

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133

RECOMMENDATION 5: LEGISLATIVE INTERVENTIONS

Writing laws is easy, but governing is difficult.

The Lower Cotter Catchment is an area of approximately 6000 hectares and it supports water supply, ecological and recreational values for the Canberra community. It is not a closed catchment and this necessitates specific regulatory interventions.

The colourful history of this catchment with its nostalgic and cultural heritage aspects, and proximity to residential areas, means that it is a hot spot for a variety of recreational uses. This brings with it many risks.

Biosecurity and the risk of exotic species are adequately addressed by the government policy interventions which are in place at this time. However these both require continued vigilance, particularly in light of the NSW Government's failure to respond to the brumby issue.

One of the largest risks is the dumping and burning of cars, from which flows an increasing risk of uncontrolled fire, impacts to water quality, human safety and significant financial costs to the government. This could be easily remediated by legislative changes allowing government authorities to immediately impound abandoned vehicles before they are burnt out.

5.1 ACT Government amend the *Road Transport (Safety and Traffic Management) Act 1999* to allow for the immediate removal of abandoned vehicles by government authorities.

5.2 ACT Government amend the *Lower Cotter Catchment Activities Declaration* to allow the restriction of public vehicular access to ecologically sensitive and isolated parts of the Lower Cotter Catchment.

Appendices



Appendix 1 – Legislation

COMMONWEALTH LEGISLATION

Australian Capital Territory (Planning and Land Management) Act 1988 (Commonwealth)

This Act requires the development of the National Capital Plan and defines National Land—managed by the Commonwealth and Territory Land—managed by the ACT Government. The Lower Cotter Catchment is on Territory Land.

Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

This Act provides for the protection of the environment including the conservation of heritage, it promotes biodiversity and provides guidance for co-operation between governments and the wider community to assist in achieving Australia's international environmental responsibilities.

ACT LEGISLATION

Water Resources Act 2007

This Act ensures that the management of ACT's water resources is conducted in a sustainable manner with a view to the needs of future generations with a focus on protecting the ecosystem and aquifers from damage. This Act defines the functions of the Environment Protection Authority and establishes the ACT Environmental Flow Guidelines and the Licence to Take Water.

Planning and Development Act 2007

This Act defines the planning and land system that supports the orderly and sustainable development of the ACT. This Act establishes the *Territory Plan 2008* and defines the roles of the Conservator and the EPA in the ACT's planning system. The *Planning and Development Act 2007* needs to be consistent with the National Capital Plan, and if not consistent it will have no effect. The *Planning and Development Act 2007*, Schedule 3, also prescribes the management objectives for different categories of public land. The objectives will remain in this Act and will not be in the new *Nature Conservation Act 2014*.

Territory Plan 2008

The *Territory Plan 2008* is established under the *Planning and Development Act 2007* and commenced on 31 March 2008. The plan gives the ACT a framework for administering the planning system, including defining land use and guidance to assess development applications. The *Territory Plan 2008* comprises maps showing the ACT land by sections and blocks—zoned for particular land uses.

Environment Protection Act 1997

This Act seeks to protect the environment from pollution and other environmental degradation including risk of harm to human health. The Act also establishes the Environment Protection Authority and gives the Authority the power to develop environment protection policies, enter environmental protection agreements, and issue environmental authorisations.

Environment Protection Regulation 2005

The regulation provides standards for treated and untreated water in a domestic water supply.

Nature Conservation Act 1980

The *Nature Conservation Act 1980* provides for the protection and conservation of wildlife, and for the reservation of areas of public land for these purposes. The act establishes the Conservator, and the PCS rangers who 'support the Conservator in the exercise of their responsibilities and for enforcement of the Act'.⁵⁶

Nature Conservation Act 2014

This Act will replace the *Nature Conservation Act 1980* and come into effect by 11 June 2015. The object of this new act is to protect, conserve and enhance the biodiversity of the ACT. The requirement for a land manager to develop a Plan of Management under the *Planning and Development Act 2007* will be transferred to this Act as a Reserve Management Plan. The ACT strengthens enforcement in reserves and recognises that water catchments are reserves with the primary function of protecting the water supply.

Pest Plants and Animals Act 2005

This Act seeks to protect the land and aquatic resources in the ACT from pest plants and animal by promoting a strategic and sustainable approach to pest management; of relevance to the Lower Cotter Catchment are the provisions for declaring pest plants and animals.

Public Health Act 1997

This Act protects the public from public health risks. The provision of drinking water by a utility requires a licence under this Act. The licence for Icon Water requires the Australian Drinking Water Guidelines to be met as far as reasonably possible. There is also a specific section which requires the water utility to provide specific information on drinking water quality to the Chief Health Officer.

Public Health (Drinking Water) Code of Practice 2007

The Code of Practice is part of a Drinking Water Utility Licence under the *Public Health Act*

1997 and specifies the technical requirements for the supply, quality, monitoring of, and reporting on drinking water in the ACT. The Code requires the utility to participate with catchment bodies in a survey every three years, reported to the Chief Health Officer, with an annual water quality report and water quality improvement plans, with strategic risks and mitigation strategies. Section 14.1 of the Code states ‘The Utility [Icon Water] must participate with the relevant water catchment management bodies for the purpose of information exchange in relation to activities in and around the catchments, which may impact on water quality (including pesticides and agricultural chemical use) in all catchments’.

Emergencies Act 2004

This Act seeks to protect and preserve life, property and the environment. The Act also establishes the strategic and governance framework for the overall response to bushfire threats and requires the Emergency Services Commissioner to develop the ACT Strategic Bushfire Management Plan. The *Emergencies Act 2004* requires the land manager of unleased territory land to develop a Bushfire Operational Plan (BOP) and to seek approval for the plan from the Emergency Services Commissioner.

Territory Owned Corporations Act 1990

This Act establishes ACTEW Corporation Limited, now Icon Water.

Commissioner for Sustainability and the Environment Act 1993

This Act establishes the Commissioner for Sustainability and the Environment who is responsible for investigating complaints, conducting investigations and reporting on the state of the environment in the ACT.

Independent Competition and Regulatory Commission Act 1997

This Act establishes the ICRC, which is, among other things, tasked to provide water price directions.

Utilities Act 2000

Icon Water must comply with the obligations set out in the Utilities Services Licence which was issued by the ICRC under this Act in June 2001.

Heritage Act 2004

The Heritage Act 2004 establishes a system for the recognition, registration and conservation of natural and cultural heritage places and objects, including Aboriginal places and objects. This Act establishes a heritage council, heritage guidelines and a heritage register, and gives the Minister the option to enter heritage agreements.

Fisheries Act 2000

The Fisheries Act regulates fishing in the ACT and provides for the conservation of native fish species and their habitats and the management of sustainable fisheries. Under this Act, the Conservator is required to prepare a management plan for the management of fish species and their habitats in the ACT.

Road Transport (Safety and Traffic Management) Act 1999

The *Road Transport (Safety and Traffic Management) Act 1999* provides for the management of abandoned cars by government authorities.

RELEVANT POLICIES

ACT Water Strategy 2014–44

The ACT Water Strategy 2014–44; Striking the Balance is the high-level water policy which informs the strategic planning of water resources to support the sustainable development of the ACT. The strategy focuses on three main outcomes:

- healthy catchments and water bodies
- a sustainable water supply used efficiently, and
- a community that values and enjoys clean, healthy catchments.

Source Water Protection Program

The Source Water Protection Program is an Icon Water strategy and program which focuses on catchment management and source water protection as the first barrier for the protection of water quality. The Source Water Protection Program addresses aspects of the Australian Drinking Water Guidelines, and is an integrated part of Icon Water’s Hazard Analysis and Critical Control Point (HACCP) model for protecting the quality of drinking water.

Water Quality Environment Protection Policy

This 2008 policy provides clarification on: the application of the *Environment Protection Act 1997* and associated regulation, and on the management of water quality.

Australian Drinking Water Guidelines 2011 (and updates)

The Australian Drinking Water Guidelines (ADWGs) are published by the National Health and Medical Research Council and the Natural Resource Management Council and provide a non-mandatory framework for the management of drinking water supplies. The ADWGs are updated regularly to reflect the best available scientific evidence.

Strategic Bushfire Management Plan

This document sets the strategic direction for bushfire management in the ACT and provides a strategic framework for government agencies with a responsibility for bushfire response and management. The ACT Bushfire Management Standards define the measurable outcomes required under the Strategic Bushfire Management Plan.

Bushfire Operational Plan

The BOP sets out the work and activities that the land manager (for the Lower Cotter Catchment that is TAMS) aims to achieve each financial year to help manage bushfire risk.

ACT Biosecurity Strategy 2016–2026

The ACT Biosecurity Strategy highlights the importance of biosecurity for the ACT and identifies the goals, objectives and supporting actions for addressing biosecurity across the Territory.

ACT Weeds Strategy 2009–19

This strategy provides for a strategic approach to weed management aimed at the reduction of the impact of weeds on the environment, economy, human health and amenity. The planning and implementation of this strategy also considers the regional and national context, such as, the list of Weeds of National Significance—which includes the blackberry that infests large areas of the Lower Cotter Catchment.

ACT Pest Animal Strategy 2012–22

This strategy aims to reduce the social, environmental and economic damage caused by pest animals. The strategy sets out how to manage animals that are already pests in the ACT as well as those that might invade the ACT, for instance: rabbits, wild dogs, foxes, feral pigs, European wasps and some introduced fish and freshwater crustaceans.

Nature Conservation Strategy 2013–23

This strategy is prepared under the *Nature Conservation Act 1980* and provides a framework that guides priority setting for the management and restoration of natural areas and biodiversity, including riparian areas. The strategy identifies the Lower Cotter Catchment as a focal landscape for restoration of the Lower Cotter Catchment's ability to provide clean water and native landscape.

ACT Aquatic Species and Riparian Zone Conservation Strategy 2007

The strategy focuses on biodiversity and habitat conservation for rivers and riparian zones, with some consideration of water resource management and recreation; it is also an

Action Plan for the management of declared threatened species: Perch, Trout Cod, Macquarie Perch, Two-spined Blackfish and Murray River Crayfish.

138

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139

Appendix 2 – Complete Reference List

In order of appearance:

1. Flood, J. 1996/2010. Moth Hunters of the Australian Capital Territory. Aboriginal Traditional Life in the Canberra Region, Gecko Books, South Australia
2. Rhodes, J. 2018. Cage of Ghosts, Darkwood, Australia
3. https://www.aph.gov.au/Parliamentary_Business/Committees/House_of_representatives_Committees?url=laca/constitutionalreform/chapter5.htm accessed 24 May 2018
4. Moggridge, B. 2018. Where is the Aboriginal Water Voice through the Current Murray-Darling Crisis? Irrigation Australia 34(02) pp. 34–35 http://www.awa.asn.au/AWA_MBRR/Publications/Latest_News/Call_to_prioritise_Aboriginal_water_rights.aspx accessed 15 August 2018
5. Davis, M. & Lemeza, Z. 2010. Indigenous Australians and the Preamble. UNSW Law Journal Volume 33(2) pp. 239–266
6. https://www.aph.gov.au/Parliamentary_Business/Committees/Joint/Constitutional_Recognition_2018/ConstRecognition/Final_Report accessed 24 May 2018
7. <http://www.ipcc.ch/report/sr15/> accessed 20 October 2018
8. Blay, J. & Eden Local Aboriginal Land Council 2011. Report on a Survey of The Bundian Way 2010–2011 http://www.bundianway.com.au/Bundian_Survey_Public.pdf accessed on 24 September 2018
9. Kabaila, P. 2005. High Country Footprints: Aboriginal pathways and movements in the high country of south eastern Australia. Recognising the ancient paths beside modern highways. Pirion Publishing, Canberra
10. Den Barber, Founding Director at Koori Country Firesticks Aboriginal Corporation spoken at the EPSDD Cultural Burning Forum, May 2018
11. ACT Auditor-General's Report, Restoration of the Lower Cotter Catchment Report No. 3/2015
12. *Commissioner for Sustainability and the Environment Act 1993*
13. ACT Government, Lower Cotter Strategic Management Plan 2007
14. Legislative Assembly Standing Committee on Public Accounts Published Report 31, Review of Auditor-General's Report No. 3/2015
15. <https://www.parliament.act.gov.au/in-committees/previous-assemblies/standing-committees-eighth-assembly/Public-Accounts/review-of-auditor-general-report-no.-3-of-2015-restoration-of-the-lower-cotter-catchment/report?inquiry=796126>, accessed 31 May 2018
16. ACT Government, Lower Cotter Catchment Reserve Management Plan 2018
17. *Nature Conservation Act 2014*
18. *Planning and Development Act 2007*
19. https://www.environment.act.gov.au/__data/assets/pdf_file/0007/919357/ACT-and-Region-Catchment-Strategy-ACCESS.pdf accessed 24 June 2018
20. ACT Public Health (Drinking Water) Code of Practice 2007
21. Australian Drinking Water Guidelines 2011
22. <https://www.iconwater.com.au/water-and-sewerage-system/sustainability-and-environment/sustainability-and-environment-programs/protecting-water-supply.aspx> accessed 6 June 2018
23. Independent Competition and Regulation Commission Final report Regulated water and sewerage services prices 2018–23
24. <https://www.choice.com.au/food-and-drink/drinks/water/articles/bottled-water> accessed 3 June 2018
25. <https://www.choice.com.au/food-and-drink/drinks/water/articles/bottled-water> accessed 3 June 2018
26. <https://www.coolaustralia.org/bottled-water-secondary/> accessed 3 June 2018
27. <https://www.coolaustralia.org/bottled-water-secondary/> accessed 3 June 2018
28. <http://www.canberra.edu.au/media-centre/2011/january/21-water> accessed 3 June 2018
29. <https://www.yvw.com.au/help-advice/community-programs/choose-tap> accessed 3 June 2018
30. ACT Government 2014. ACT Water Strategy 2014–44: Striking the Balance
31. Australian Government 2012. Murray-Darling Basin Plan
32. <http://www.act.waterwatch.org.au/> accessed 12 June 2018
33. https://www.environment.act.gov.au/water/water_quality/act_water_reports accessed 12 June 2018
34. <http://www.act.waterwatch.org.au/chip.html> accessed 12 June 2018
35. <http://sactcg.org.au/node/915> accessed 13 June 2018
36. <https://www.environment.act.gov.au/water/ACT-Healthy-Waterways/home> accessed 14 March 2018
37. ACT Government 2018, Integrated Water Monitoring Plan
38. ACT Government Digital Strategy 2016–2019
39. https://www.environment.act.gov.au/__data/assets/pdf_file/0019/621424/ACT-Water-Strategy-ACCESS.pdf accessed 24 June 2018
40. https://www.greeningaustralia.org.au/wp-content/uploads/2017/11/CASE-STUDY_Regreening-the-Cotter.pdf
41. Actew AGL Environmental Impact Statement, Enlargement of the Cotter Reservoir, Volume 2, 2009
42. ACT Auditor-General's Report, Restoration of the Lower Cotter Catchment, Report No. 3/15
43. University of Canberra 2018. Lower Cotter Catchment: monitoring and evaluation framework for the protection of water and ecological values
44. ACT Auditor-General's Report, Restoration of the Lower Cotter Catchment, Report No. 3/15
45. Government response to PAC Report 31 – Review of the Auditor-General's Report No. 3 of 2015 – Restoration of the Lower Cotter Catchment, December 2016
46. ACT Auditor-General's Report, Restoration of the Lower Cotter Catchment, Report No. 3/15
47. Pers. Comm., email from Icon Water, 28 June 2018
48. <https://www.canberratimes.com.au/national/act/canberras-rugby-water-usage-equivalent-to-1970s-when-city-half-the-size-20170804-gxp31.html> accessed 2 June 2018
49. Icon Water 2017, Annual Report 16–17
50. <https://www.canberratimes.com.au/politics/act/while-one-third-nsw-in-drought-act-has-cancelled-extra-water-licence-20180619-p4zmfl.html> accessed June 24 2018
51. <https://www.iconwater.com.au/> accessed 12 February 2018 and 1 September 2018
52. <https://www.theguardian.com/environment/2018/aug/08/nsw-declared-100-in-drought-as-farmers-fear-reli-ef-package-too-late> accessed 8 August 2018
53. Icon Water Annual Drinking Water Quality Report 2016–17 web. pdf accessed June 6 2018
54. ACT State of the Environment Report <http://reports.envcomm.act.gov.au/actsoe2015/the-report/6-water/6-2-introduction/index.html> accessed 8 August 2018
55. Sayer, J. & C. Margules 2017. Biodiversity in Locally Managed Lands. Land 2017, 6(2)
56. http://smapp.rand.org/ise/ourfuture/NaturesServices/sec1_watershed.html accessed Feb 10 2018 accessed 5 February 2018
57. <https://www.dpaw.wa.gov.au/management/fire/fire-and-the-environment/> accessed 17 September 2018

58. Flood, J. 1980. The Moth Hunters: Aboriginal Prehistory of the Australian Alps
59. Butz, M. 2003. Conservation Management Plan for Shannons Flat and Blundells Flat ACT
60. Daniell, T. & I. White, 2005. Bushfires and their implications for management of future water supplies in the Australian Capital Territory
61. Brett McNamara quoted in Kaufman, R. 2006. Remembering the Lost Places. Australian Alps Liaison Committee
62. ACT Government State of the Environment Report 2015
63. Pausas J. & J. Keeley 2009. A Burning Story: The Role of Fire in the History of Life. *BioScience*, Volume 59, Issue 7
64. Union of Concerned Scientists 2017. Confronting Climate Change in Oregon: Current Impacts and future risks, <http://www.ucsusa.org/sites/default/files/attach/2015/03/ucs-confronting-climate-change-oregon-2015.pdf>
65. Hughes L. & D. Alexander 2017. Climate Change and the Victoria Bushfire Threat: Update 2017, Climate Council of Australia Ltd., Australia
66. Steering Committee for the Review of Government Service Provision 2016. Report on Government Services 2016, vol. D, Emergency Management, Productivity Commission, Canberra, Australia
67. Actew AGL 2009, Environmental Impact Statement, Volume 1
68. ACT Government, Lower Cotter Catchment Reserve Management Plan 2018
69. Vegetation Assessment State and Transitions; <http://vasttransformations.com/>
70. Resilience Alliance's Workbook for Practitioners (<https://www.resalliance.org/resilience-assessment>).
71. Butz, M. 2009. Conservation management plan: Blundells Flat and Shannons Flat, ACT, Part A-H. Report provided to the ACT Government through the ACT Heritage Grants Program – HG04/22
72. Thackway, R. 2013. Transformation of Australia's Vegetated Landscapes, Blundells Flat, ex-coupe 424, ACT. Australian Centre for Ecological Analysis and Synthesis, University of Queensland, Brisbane
73. Thackway, R. & Freudenberger, D. 2016. Accounting for the drivers that degrade and restore landscape functions in Australia. *Land*, 5, 40
74. White, I., Wade, A. Worthy, A., Mueller, N., Daniell, T. & Wasson, R. 2006. The vulnerability of water supply catchments to bushfires: impacts of the January 2003 wildfires on the Australian Capital Territory. *Australian Journal of Water Resources*. 10, 179–194
75. <http://www.environment.act.gov.au/home/Bush-Capital/bettongs-bounce-back> accessed 10 June 2018
76. https://www.cmtedd.act.gov.au/open_government/inform/act_government_media_releases/esdd/2017/have-your-say-on-protecting-canberra-bettongs accessed 22 August 2018
77. <http://www.abc.net.au/news/2017-04-02/eastern-bettongs-breeding-in-the-wild-on-mainland-australia/8406432> accessed 13 June 2018
78. Bartlett, T., Butz, M., Kanowski, P. 2003. Engaging the Community in Reforestation Following the Canberra Bushfire
79. Per comms. Meeting with Senior Project Manager, Greening Australia, January 2018
80. ACT Government, Director's-General Water Group Minutes May 2015
81. Lower Cotter Catchment Implementation Coordination Group Terms of Reference
82. Echelon Australia, Lower Cotter Catchment Risk Treatment Plan 2016
83. ACT Government, Director's-General Water Group Meeting Minutes June 2016
84. ACT Government, Lower Cotter Catchment Reserve Management Plan 2018
85. Landloch Report 2006, 2008, 2015.
86. Landloch 2015 Inspection of Gullying and other Land Management Issues, Lower Cotter Catchment; Report prepared for the ACT Parks and Conservation Service.
87. Sydney Catchment Authority 2009 Prioritising Catchment Actions – The Catchment Decision Support Systems 2009–2010
88. Water NSW 2018 Website accessed 7 September 2018 https://www.watarnsw.com.au/__data/assets/pdf_file/0007/133927/WaterNSW-Catchment-Protection-Work-Program-2017-18.pdf
89. ACT Government, Parks and Conservation Service Blue Range Rehabilitation Plan 2015–2018
90. https://www.environment.act.gov.au/water/water_planning_and_management/act_water_abstraction_charge accessed 19 June 2018
91. *Disallowable Instrument DI2003–333 Utilities (Water Abstraction Charge) Ministerial Direction 2003 (No 1)*
92. Australian Competition and Consumer Commission
93. ACCC Water Monitoring Report 2016–17.pdf accessed 19 June 2018
94. ACT Government 2017–2018 Budget paper No. 3
95. <https://www.environment.gov.au/biodiversity/invasive/weeds/publications/guidelines/wons/pubs/r-fruticosus.pdf> accessed 22 March 2018
96. *Pest Plants and Animals Act 2005*
97. Pers. Comm. Email from Parks and Conservation Service, 2 February 2018
98. Australian Association of Bush Regenerators: http://www.aabr.org.au/images/stories/resources/ManagementGuides/WeedGuides/wmg_Blackberry.pdf accessed 25 March 2018
99. Pers. Comm., comments during Expert Reference Group meeting, Parks and Conservation Service, 9 February 2018
100. Morin, L. & K. Evans 2012. *Rubus fruticosus* L. agg. – European blackberry. In: *Biological control of weeds in Australia 1960 to 2010*, (eds. Julien M, Cruttwell McFadyen R, Cullen JM), 499–509. CSIRO Publishing, Collingwood, Australia
101. <http://www.wri.org/blog/2017/12/restoration-one-most-overlooked-opportunities-economic-growth> accessed 10 February 2018
102. <https://www.mdba.gov.au/sites/default/files/archived/proposed/NRM-MERI-Framework.pdf> accessed 12 September 2018
103. Birge, H., Allen, C., Garmestani A. & K. Pope 2016. Adaptive management for ecosystem services. *Journal of Environmental Management*
104. 183(Part 2):343-352
105. Lovett, G., Burns, D., Driscoll, C., Jenkins, J., Mitchell, M., Rustad, L., Shanley, J., Likens, G. & R. Haeuber. 2007. Who needs environmental monitoring? *Frontiers in Ecology and the Environment* 5(5):253–260
106. <https://www.mdba.gov.au/sites/default/files/archived/proposed/NRM-MERI-Framework.pdf> accessed 12 September 2018
107. Office of the Commissioner for Sustainability and the Environment, 2017. Implementation Status Report on Climate Change Policy
108. Lindenmayer, D. & G. Likens 2018. Effective Ecological Monitoring. CSIRO Publishing, Collingwood, Australia
109. <https://www.mdba.gov.au/sites/default/files/archived/proposed/NRM-MERI-Framework.pdf> accessed 12 September
110. Australian Capital Territory Licence to Take Water Under the *Water Resources Act 2007*
111. <https://www.iconwater.com.au/water-and-sewerage-system/our-projects/water-security-projects/enlarged-cotter-dam/protecting-native-fish-species.aspx> accessed 16 October 2018

112. <https://www.iconwater.com.au/water-and-sewerage-system/our-projects/water-security-projects/enlarged-cotter-dam/protecting-native-fish-species.aspx> accessed 16 October 2018
113. Icon Water 2018. Report to the Commonwealth Department of the Environment and Energy: Annual Performance Report (2017) against the Enlarged Cotter Dam Fish Management Plan Version 3
114. Icon Water 2014, Enlarged Cotter Dam Fish Management Plan, Version 3, November 2013
115. <http://www.mldrin.org.au/> accessed 4 March 2018
116. <https://www.mdba.gov.au/sites/default/files/pubs/BPE-report-2017.pdf> accessed 20 September 2018
117. <http://www.mldrin.org.au/what-we-do/cultural-flows/> accessed 4 March 2018
118. <http://www.mldrin.org.au/wp-content/uploads/2018/06/Community-Guide.pdf> accessed 4 March 2018
119. J. Behrendt & P. Thompson, 2003. The Recognition and Protection of Aboriginal Interests in NSW Rivers, Healthy Rivers Commission of New South Wales
120. <http://nwc.gov.au/> – 2009, 2011, 2013, 2014
121. <http://webarchive.nla.gov.au/gov/20160615062247/http://www.nwc.gov.au/publications/topic/assessments/australias-water-blueprint-national-reform-assessment-2014>
122. <https://www.pc.gov.au/inquiries/completed/water-reform#report>
123. Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000
124. B. Moggridge & R. Mihiniui, 2010. Indigenous principles for water quality – <http://www.waterquality.gov.au/anz-guidelines/guideline-values/derive/cultural-values/principles>
125. <http://www.environment.gov.au/science/environmental-economic-accounting> accessed 12 July 2018
126. <https://seea.un.org/> accessed 12 July 2018
127. <http://www.abs.gov.au/ausstats/abs@.nsf/mf/4655.0> accessed 12 July 2018
128. <http://www.environment.gov.au/science/environmental-economic-accounting> accessed 12 July 2018
129. http://www.environmentcommissioner.act.gov.au/__data/assets/pdf_file/0012/1106301/Environmental-Economic-Accounts-for-ACT-state-of-the-environment-reporting-Proof-of-Concept-A151125412.pdf accessed 12 July 2018
130. http://www.environmentcommissioner.act.gov.au/__data/assets/pdf_file/0012/1106301/Environmental-Economic-Accounts-for-ACT-state-of-the-environment-reporting-Proof-of-Concept-A151125412.pdf accessed 12 July 2018
131. https://www.environment.act.gov.au/__data/assets/pdf_file/0004/1059241/Conservation-effectiveness-monitoring-program.pdf accessed 22 May 2018
132. The National Water Quality Management Strategy 2000
133. <http://www.waterquality.gov.au/anz-guidelines/resources/previous-guidelines/anzec-armcanz-2000> accessed 1 December 2017
134. https://www.climatecouncil.org.au/wp-content/uploads/2018/06/CC_MVSA0146-Fact-Sheet-Drought_V2-FA_High-Res_Single-Pages.pdf accessed 18 October 2018
135. https://newclimateeconomy.report/2018/wp-content/uploads/sites/6/2018/09/NCE_2018_WATER.pdf accessed 15 September 2018
136. <http://theconversation.com/ecosystems-across-australia-are-collapsing-under-climate-change-99367> accessed 5 July 2018
137. ACT Government 2010, Namadgi National Park Plan of Management 2010
138. <https://www.mdba.gov.au/discover-basin/landscape/climate> accessed 18 October 2018
139. https://newclimateeconomy.report/2018/wp-content/uploads/sites/6/2018/09/NCE_2018_WATER.pdf accessed 15 September 2018
140. <http://www.agriculture.gov.au/water/quality/bushfires-and-water-quality> accessed 18 October 2018
141. James Horne 2018. Resilience in major Australian cities: assessing capacity and preparedness to respond to extreme weather events. *International Journal of Water Resources Development* 34:4, pages 632–651
142. <https://www.dpi.nsw.gov.au/climate-and-emergencies/droughthub/information-and-resources/seasonal-conditions/ssu/september-2018> accessed 30 September 2018
143. Canberra Times article: <http://www.abc.net.au/news/2016-11-24/more-than-500-cars-abandoned-on-act-roadsides-last-year/8035048> accessed 10 May 2018
144. ACT Government EPA 2018. Licence to Take Water WU67
145. Pers. Comm., email from Icon Water, 28 June 2018
146. http://report.ipcc.ch/sr15/pdf/sr15_chapter3.pdf accessed 15 October 2018
147. <http://www.agriculture.gov.au/water/policy/nwi/climate-change>
148. Sydney Morning Herald accessed 4 October 2018
149. Bureau of Meteorology, 2016. State of the Climate
150. SR15, IPCC, 2018
151. <https://www.iconwater.com.au/water-and-sewerage-system/water-and-sewerage-system/water-for-generations.aspx> accessed 10 September 2018
152. <https://www.weforum.org/agenda/2015/01/why-world-water-crises-are-a-top-global-risk/> accessed 2 Feb 2018
153. <http://infrastructureaustralia.gov.au/policy-publications/publications/reforming-urban-water.aspx> accessed 12 October 2018
154. <http://www.anu.edu.au/news/all-news/big-drought-in-australia-linked-to-spike-in-gastro-cases> accessed 12 October 2018
155. Public Health (Drinking Water) Code of Practice 2007
156. <http://health.act.gov.au/datapublications/reports/chief-health-officers-report> accessed 25 September 2018
157. <https://www.canberratimes.com.au/national/act/antibiotics-not-enough-to-stop-deadly-superbugs-study-finds-20180901-p50167.html> accessed 2 September 2018
158. http://report.ipcc.ch/sr15/pdf/sr15_chapter3.pdf accessed 15 October 2018
159. Pers. Comm., email from Parks and Conservation Service, 28 June 2018
160. <https://www.abc.net.au/news/2018-11-05/canberra-fire-burnt-car-parks-rangers/10465530> accessed 5 November 2018
161. <http://www.latrobevalleyexpress.com.au/story/4945140/dumped-car-fire-risk/> accessed 18 June 2018
162. Pers. Comm., email from University of Melbourne, 24 July 2018
163. *Road Transport (Safety and Traffic Management) Act 1999*
164. Canberra Times article: <http://www.abc.net.au/news/2016-11-24/more-than-500-cars-abandoned-on-act-roadsides-last-year/8035048> accessed 10 May 2018
165. <http://www.abc.net.au/news/2016-11-24/more-than-500-cars-abandoned-on-act-roadsides-last-year/8035048> accessed 10 May 2018
166. <https://www.cessnockadvertiser.com.au/story/4968117/dumped-cars-a-nightmare/> accessed 10 May 2018
167. <https://www.environment.act.gov.au/home/Bush-Capital/a-catchment-worth-protecting> accessed 20 June 2018
168. <https://www.queanbeyanagechronicle.com.au/story/5469654/drag-the-wild-horses-away/?cs=1907> accessed 19 June 2018, <http://citynews.com.au/2018/feral-horses-threaten-act-drinking-water/> accessed 8 June 2018
169. Hosking, G. 2016. Investigating Deer Habitat Use by Indirect Methods, in South-East Australia: A Pilot Study. Australian National University undergraduate research project
170. Monitoring Impacts of Sambar Deer, https://www.environment.act.gov.au/__data/assets/pdf_file/0003/1149015/Technical-report-MONITORING-IMPACTS-OF-SAMBAR-DEER-October-2017.pdf accessed 8 June 2018

171. Davis, N., Bennett, A., Forsyth, D., Bowman D., Lefroy, E., Wood, S., Woolnough, A., West, P., Hampton, J. & C. Johnson 2016. A systematic review of the impacts and management of introduced deer (family Cervidae) in Australia. *Wildlife Research*, 43, 515–532.
172. Burgin, S., Mattila, M., McPhee, D. & T. Hundloe 2015. Feral deer in the suburbs: An emerging issue for Australia? *Human Dimensions of Wildlife*, 20, 65–80
173. Canberra Weekly 21 June 2018 edition accessed 25 June 2018
174. ACT Government Biosecurity Strategy 2016–2026
175. Vermeulen, E., Ashworth, D., Eldridge, M. & M. Power 2015. Investigation into potential transmission sources of *Giardia duodenalis* in a threatened marsupial (*Petrogale penicillata*), *Infection, Genetics and Evolution*. Volume 33, 2015.
176. Howarth, R., Anderson, D., Cloern, J., Elfring, C., Hopkinson, C., Lapointe, B. & D. Walker 2000. Issues in ecology: Nutrient pollution of coastal rivers, bays, and seas.
177. *Kosciuszko Wild Horse Heritage Bill 2018*
178. <https://www.environment.nsw.gov.au/resources/protectsnowies/knp-wild-horse-plan-draft-160271.pdf> accessed October 23 2018
179. http://seraustrolasia.com/wheel/image/SER_International_Standards.pdf accessed 18 September 2018
180. <http://reports.envcomm.act.gov.au/actsoe2015/the-report/6-water/index.html> accessed 18 September 2018
181. www.researchgate.net/publication/313840447_Drone_Applications_for_Environmental_Management_in_Urban_Spaces_A_Review accessed 15 October 2018
182. www.abc.net.au/news/2015-03-01/drones-used-to-wage-war-on-blackberry-brambles-near-canberra/6126334 accessed 12 May 2018
183. Seminar by Dr David Paull, UNSW Canberra – Unmanned Aerial Vehicles to Measure and Monitor Streambank Impacts of Wild Horses in the Australian Alps
184. Government of South Australia 2010. Habitat Restoration Planning Guide for Natural Resource Managers
185. https://newclimateeconomy.report/2018/wp-content/uploads/sites/6/2018/09/NCE_2018_WATER.pdf accessed 15 September 2018

142

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143

Appendix 3 – Water Quality Monitoring and Evaluation Schedule for Lower Cotter Catchment

LOWER COTTER CATCHMENT MONITORING PROGRAM

RISK	ACTIVITY	INDICATOR	HOW	WHERE	WHEN	WHO
Sediment	Road network	NTU (mg/L)	Probe	5 Sites	Online continuous	Icon Water
	Controlled fire	Rainfall (mm)	Probe / gauge	5 Sites	Online continuous	Icon Water
	Uncontrolled fire	Metals suite*	Grab	5 Sites	Quarterly	Icon Water
	Recreational access	Solids suite ^	Grab	5 Sites	Quarterly	Icon Water
	Pest animal species	Nutrients suite #	Grab	5 Sites	Quarterly	Icon Water
	Commercial forestry	Gully erosion assessment	LiDAR and aerial imagery analysis, combined with ground survey methods (erosion/deposition pins, marker flags, cross-sections) measuring gully evolution	Lower Cotter Catchment	Annually	Land manager, PCS
		Bare ground %	Spectroscopic analysis of existing ACT Gov annual RGB aerial imagery	Sub-catchment level	Annually	Land manager, PCS
		Traffic	Traffic counters 3 induction-loop counters permanently installed	6 primary vehicular access points	Monthly data retrieval	Land manager, PCS
		Road to Waterway connectivity kms % road network closed	Remote sensing and ground survey Sediment traps	Whole Lower Cotter Catchment	Annually	Land manager, PCS
		NTU (mg/L)	Probe	5 baseline + 5 additional Sites	Online continuous	Icon Water
		Rainfall (mm)	Probe / gauge	5 baseline + 5 additional Sites	Online continuous	Icon Water
		Metals suite*	Grab	5 baseline + 5 additional Sites	Quarterly	Icon Water
		Solids suite ^	Grab	5 baseline + 5 additional Sites	Quarterly	Icon Water
		Nutrients suite #	Grab	5 baseline + 5 additional Sites	Quarterly	Icon Water
		Gully erosion assessment	LiDAR and aerial imagery analysis, combined with ground survey methods (erosion/deposition pins, marker flags, cross-sections) measuring gully evolution	Whole Lower Cotter Catchment	Annually	Land manager, PCS
		Bare ground %	Spectroscopic analysis of existing ACT Gov annual RGB aerial imagery	Sub-catchment level	Annually	Land manager, PCS
		Traffic	Traffic counters 3 induction-loop counters permanently installed	6 primary vehicular access points	Monthly data retrieval	Land manager, PCS

RISK	ACTIVITY	INDICATOR	HOW	WHERE	WHEN	WHO
		Vegetation mapping	Native plant species richness, riparian biometric condition score, native species cover, median canopy height, existing LFA and floristics mapping	Lower Cotter Catchment total (replicated transect sites across the major vegetation communities)	2020 / 2022 / 2025	Land manager, PCS
		Sediment Budget	Model	Lower Cotter Catchment total and by Lower Cotter Catchment sub-catchment	2020 / 2022 / 2025	Land manager, PCS
		Pest Animal Species	Scat count Presence / absence Scent Lure Lidar Browsing plots Combined rabbit, deer and macropod presence/absence monitoring (transect scat-counts) across the six vegetation types (natural and derived). Pig presence/absence monitoring (ripping) in Blundells Flat Carex Fen. Camera traps	Lower Cotter Catchment total and by Lower Cotter Catchment sub-catchment	Seasonally (bi-annually)	Land manager, PCS
Controlled Fire – event monitoring Conduct for 3 events		NTU (mg/L)	Probe	2 sites – one upstream and one downstream from burn area	Online continuous: 1. Before burn 2. At least 6 months post burn (and until returns to pre burn level)	Fire, Forests and Roads, PCS
		Rainfall (mm)	Probe / gauge	2 sites – one upstream and one downstream from burn area	Online continuous: 1. Before burn 2. At least 6 months post burn (and until returns to pre burn level)	Fire, Forests and Roads, PCS
		Metals suite*	Grab	2 sites – one upstream and one downstream from burn area	Before burn 3 months post burn 6 months post burn	Fire, Forests and Roads, PCS
		Solids suite ^	Grab	2 sites – one upstream and one downstream from burn area	Before burn 3 months post burn 6 months post burn	Fire, Forests and Roads, PCS
		Nutrients suite #	Grab	2 sites – one upstream and one downstream from burn area	Before burn 3 months post burn 6 months post burn	Fire, Forests and Roads, PCS
		Bare ground %	Spectroscopic analysis RGB aerial imagery	Proposed burn area	Before burn 3 months post burn 6 months post burn	Land manager, PCS

RISK	ACTIVITY	INDICATOR	HOW	WHERE	WHEN	WHO
		Fire parameters	LiDAR derived fuel map Canopy top height Leaf cover fraction Canopy fuel Vegetation cover Fire severity Fuel load	Proposed burn area	Before burn 3 months post burn 6 months post burn	Fire, Forests and Roads, PCS
	Road Network (made dormant or extinct) – event monitoring Conduct for 3 events / areas	Bare ground %	Spectroscopic analysis RGB aerial imagery	Across activity area	Bi-annually	Land manager, PCS
		Vegetation mapping	Landscape Function Analysis, native plant species richness, riparian biometric condition score, native species cover, median canopy height	Across activity area	Bi-annually	Land manager, PCS
		Weed species parameters	Vegetation mapping Presence / absence	Across activity area	Bi-annually	Land manager, PCS
		Road to Waterway connectivity kms % road network closed	Remote sensing and ground survey	Across activity area	Bi-annually	Land manager, PCS
	Forestry harvest activity	NTU (mg/L)	Probe	2 sites – one upstream and one downstream from pine harvest area	Online continuous: 1. Before harvest 2. Up to 6 months post harvest (or until returns to pre harvest level)	Fire, Forests and Roads, PCS
		Rainfall (mm)	Probe / gauge	2 sites – one upstream and one downstream from pine harvest area	Online continuous: 1. Before harvest 2. Up to 6 months post harvest (or until returns to pre harvest level)	Fire, Forests and Roads, PCS
		Metals suite*	Grab	2 sites – one upstream and one downstream from pine harvest area	Before harvest 3 months post harvest 6 months post harvest	Fire, Forests and Roads, PCS
		Solids suite ^	Grab	2 sites – one upstream and one downstream from pine harvest area	Before harvest 3 months post harvest 6 months post harvest	Fire, Forests and Roads, PCS
	Cotter Reservoir increasing source as drinking water supply (reservoir drawdown)	Sediment model	Model	Across Enlarged Cotter Reservoir – spatial and depth	Annually during draw down	Icon Water

RISK	ACTIVITY	INDICATOR	HOW	WHERE	WHEN	WHO
Herbicides	Pest weed control	Herbicides	Grab	5 Sites	Quarterly	Icon Water
		SOP	Audit	Desk top	Annually	Land manager, PCS
		Herbicides	Grab	5 baseline + 5 additional Sites	Quarterly	Icon Water
Pesticides	Pest animal control	Pesticides	Grab	5 Sites	Quarterly	Icon Water
		SOP	Audit	Desk top	Annually	Land manager, PCS
		Pesticides	Grab	5 baseline + 5 additional Sites	Quarterly	Icon Water
Pathogens	Pest animal species Recreational access	Pathogen suite @	Grab	5 sites across Reservoir	Bi-annually	Icon Water
		Pest Animal Species	Scat count Presence / absence Scent Lure LiDAR Browsing plots Combined rabbit, deer and macropod presence/absence monitoring (transect scat-counts) across the six vegetation types (natural and derived). Pig presence/absence monitoring (ripping) in Blundells Flat Carex Fen. Camera traps	Lower Cotter Catchment total and by Lower Cotter Catchment sub-catchment	Annually	Land manager, PCS
		Pathogen suite @	Grab	5 baseline + 5 additional Sites	Bi-annually	Icon Water
		Pathogen modelling	Model	Lower Cotter Catchment total and by Lower Cotter Catchment sub-catchment	Once every 5 years	Icon Water
Metals	Metal mobilisation	Metals suite*				
		Metals suite*				
		Metals modelling	Model	Across Enlarged Cotter Reservoir – spatial and depth	Once every 5 years	Icon Water
Algae	Eutrophication	Nutrients suite #				
		Cyanobacteria	Grab	5 sites across Reservoir	Seasonally	Icon Water
		Chlorophyll-a	Probe	5 sites across Reservoir	Seasonally	Icon Water
		Nutrients suite #				
		Cyanobacteria	Grab	5 baseline + 5 additional Sites	Seasonally	Icon Water
		Chlorophyll-a	Probe	5 baseline + 5 additional Sites	Seasonally	Icon Water
		Eutrophication modelling	Model	Across Enlarged Cotter Reservoir – spatial and depth	Once every 5 years	Icon Water

RISK	INDICATOR	MONITORING REQUIREMENT
* metals	Dissolved and Total: Fe, Mn, Zn, Cu, Al, As, Ba, Be, Cd, Co, Cr, Hg, Mb, Ni, Pb, Se, Au	<p>Monitor metals type and movement entering from tributaries. Metals suites generally form one analytical price. Key metals that must be monitored include Fe, Mn, Al as these particularly impact water treatment processes.</p> <p>Metals can be remobilised and impact drinking water treatment processes as well as aquatic flora and fauna.</p>
^ solids	TSS, TS, TDS, TOC, DOC, TDS	<p>Monitor sediment type and movement entering from tributaries.</p> <p>Solids can carry metals and deposit into the reservoir contributing to sediment filling the reservoir. This can impact water treatment processes if the reservoir 'turns over' and remobilises sediment and metals. This can impact water treatment processes as well as aquatic flora and fauna.</p>
# nutrients	TP, OP, TN, TKN, NH3, NOx	<p>Monitor nutrient type and form entering the reservoir from tributaries.</p> <p>Nutrients contribute to possible eutrophication of the drinking water supply. Nutrients in excess can also impact aquatic flora and fauna.</p>
@ pathogens	Total coliforms, <i>E coli</i> , <i>Enterococci</i> , Crypto, Giardia	<p>Monitor pathogen type and form entering the reservoir from tributaries.</p> <p>Pathogen type and quantity impacts drinking water treatment processes and if not eliminated can impact human health.</p>



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