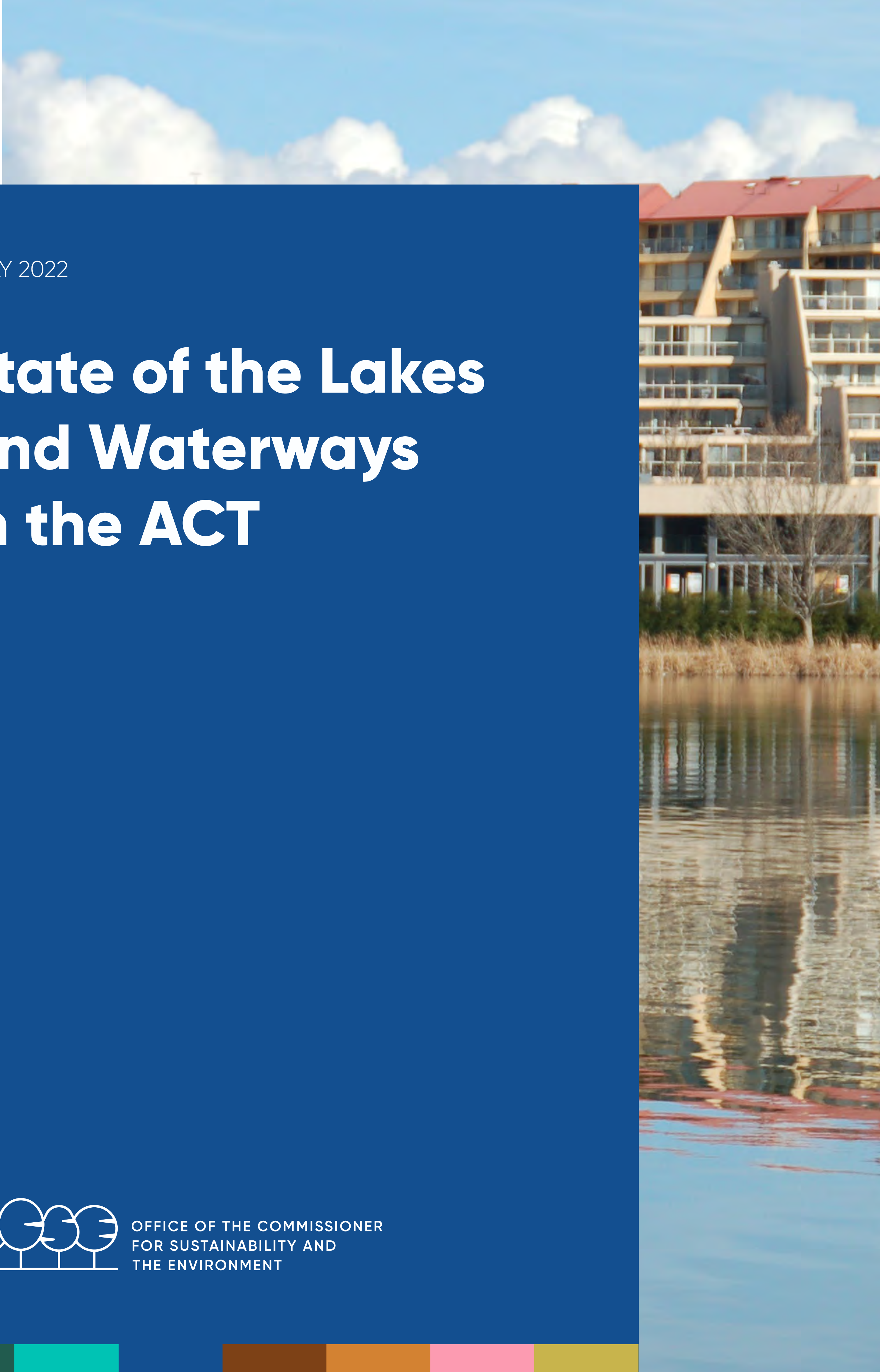

MAY 2022

# State of the Lakes and Waterways in the ACT

OFFICE OF THE COMMISSIONER
FOR SUSTAINABILITY AND
THE ENVIRONMENT

# Acknowledgements

| | |
|---|---|
| **Main authors:** | Staff from the Office of the Commissioner for Sustainability and the Environment |
| **Key technical analysis:** | University of Canberra Centre for Applied Water Science and Alluvium Consulting Australia |
| **Contributions:** | Fiona Spier, Kathryn McGilp, Jeannine Fromholtz, Karissa Preuss, Professor Ian Falconer, Woo O'Reilly, Danswell Starrs, Kate Harriden, Adam Leavesley, Birgita Hansen.<br>Contributions were also received from many other sources and the authors were grateful for them |
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For further information, contact:
Office of the Commissioner for Sustainability and the Environment
GPO Box 158, Canberra ACT 2601

**Telephone:** (02) 6207 2626

**Email:** envcomm@act.gov.au

**Website:** www.envcomm.act.gov.au



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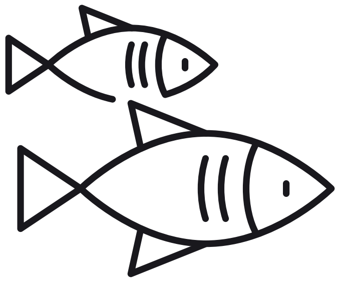

May 2022

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THE ENVIRONMENT

# Contents

## Ngunnawal Translation

Dhawura nguna ngurumbangu gunanggu Ngunnawal

Nginggada dindi dhawura Ngunnawalbun yindjumaralidjinyin

Mura bidji mulanggaridjindjula

Naraganawaliyiri yarabindjula.

## English Translation

This country is Ngunnawal ancestral, spiritual homeland

We all always respect elders, male and female, as well as Ngunnawal country itself

They always keep the pathways of their ancestors alive

They walk together as one.

# Foreword

The 2012 Report on the State of the Watercourses and Catchments for Lake Burley Griffin outlined 17 recommendations to address poor water quality. These aimed to improve the availability of the lake for recreational use through in-lake treatments, urban and rural catchment management, sewage management and river management, and strengthen the coordination of catchment management.

Water quality in the ACT's urban lakes and waterways remains an issue of environmental concern some 10 years on. Indeed, not all 2012 recommendations have yet been fully addressed. The recent summers of 2020–21 and 2021-22 were characterised by frequent reports of blue-green algal outbreaks in Lake Tuggeranong and Lake Burley Griffin, and consequent lake closures.

These outbreaks reveal complex, significant and enduring issues in the urban lakes and waters of the ACT. The 2019 State of the Environment Report assessed recreational water quality conditions as 'poor' and as having decreased for both our lakes and rivers. Aquatic ecosystem health was of poor condition in urban and rural areas, which was attributed to land use pressures.

Nearly every monitored recreation site experienced closures due to the exceedance of enterococci guidelines, and blue-green algae has required extended closures in Canberra's lakes. Lake Tuggeranong was closed for most of the 2018–19 recreational swim season due to poor recreational water quality.

The urban lakes and waterways are deeply important to Canberrans. These are areas of immense social value and sources of community wellbeing. Our wetlands, ponds, lakes, creeks and rivers are highly valued by the community and provide opportunities to interact with the natural environment. My own commute takes me from the Dickson and Lyneham Wetlands, along the Sullivan's Creek corridor before arriving in Civic to our office space overlooking Lake Burley Griffin.

Although the 2019 State of the Environment Report highlighted areas for concern in water quality, it also revealed urban areas that showed healthy aquatic systems. These demonstrate that ecosystem health can be supported with effective management and water sensitive urban design.

The question remains — how do we build on these environmental wins with increasing pressures from climate change and urban development? It is within this context that Minister for the Environment, Rebecca Vassarotti, directed this Investigation be undertaken.

The Investigation area includes Lake Burley Griffin, Lake Ginninderra, Lake Tuggeranong and the waterways that flow through the urban area and into the Murrumbidgee River, including urban ponds and wetlands and the Molonglo River and tributaries.

There is no simple 'fix' to improve the state of Canberra's lakes and waterways. Our urban lakes and ponds perform multiple — and sometimes competing — social, environmental, infrastructure and economic roles. The Investigation finds a number of weaknesses in the planning, design, delivery and operation of infrastructure, and significant issues in the management of land development in Canberra that directly impact our waterways.

My recommendations focus on catchment-scale management and planning to address the current and emerging pressures on urban lakes and waterways. Such an approach is critical for avoiding the need for a renewed investigation in another decade's time.

Dr Sophie Lewis
Commissioner for Sustainability and the Environment

*Little Pied Commorant. Source: Ryan Colley*

# Summary

Canberra is the largest urban centre within the Murray-Darling Basin. It includes three major constructed lakes and 198 constructed urban ponds and wetlands. The Molonglo River, Ginninderra Creek, Tuggeranong Creek, Sullivans Creek and Yarralumla Creek flow through Canberra's suburban area. The Ngunnawal People — the region's first inhabitants — have ongoing deep cultural roots to the water courses and byways of the ACT.

Many of these lakes and waterways were constructed or modified to manage the impacts of urban runoff, functioning as a stormwater treatment system. While urban lakes and waterways serve the two main purposes of minimising flood risk and managing urban water quality, these are not their sole functions. The constructed waterways are highly valued by the Canberra community and have been shown to provide opportunities for recreation, environmental education and enhanced social wellbeing. Further environmental benefits of Canberra's urban lakes and waterways include provision of valuable habitats, erosion prevention and protection of biodiversity.

The management and governance arrangements relating to the ACT's urban waterways is complex, with several different parts of government holding responsibility through various policies, plans and strategies. There is no single entity responsible for catchment-wide planning and management. It spans four ACT Government directorates, and often multiple different teams within those directorates, as well as the Commonwealth Government's National Capital Authority. These different entities must coordinate and collaborate in order to implement effectively the policies. Furthermore, the community plays a key role in managing the quality of urban lakes and waterways, including through direct comment on government policies and active on-ground community-based groups that care for wetlands and ponds. This Investigation notes that an increased involvement of Ngunnawal Traditional Knowledge in management is essential for improving the condition of the ACT's waterways.

The condition of Canberra's urban lakes and waterways is assessed against environmental and management objectives, and community expectations. Urban lakes and waterways are impacted by several factors, including stormwater runoff, sewage treatment discharges and recreational activities.

This Investigation finds:

- Lake Burley Griffin receives already degraded water via the Molonglo River, with the quality of water dependent on management and aquatic health in NSW and the ACT.
- Lake Tuggeranong often has poor water quality and regularly suffers from cyanobacterial blooms and high levels of faecal contamination.
- Lake Ginninderra has not had a history of significant water quality issues that have led to extensive lake closures, however it does not appear to be effectively mitigating the effects of urbanisation for the downstream receiving waters.

Water quality in any individual water body can be highly variable and depends on a range of conditions and events. In addition, long term consistent data sets are not available for many sites within the ACT monitoring network, which presents a significant knowledge gap.

This Investigation finds several weaknesses in management of urban lakes and waterways. Current policies and strategies are not well integrated and do not adequately address catchment management at an urban scale. There is currently no clear governance structure to guide strategic decision-making for protecting and improving the health of urban lakes and waterways. Flow and water quality objectives in urban lakes, ponds and waterways are not well defined for the range of social and environmental values that they provide. This Investigation finds that Water Sensitive Urban Design (WSUD) assets are generally cost-effective, but their operation and maintenance is under-resourced.

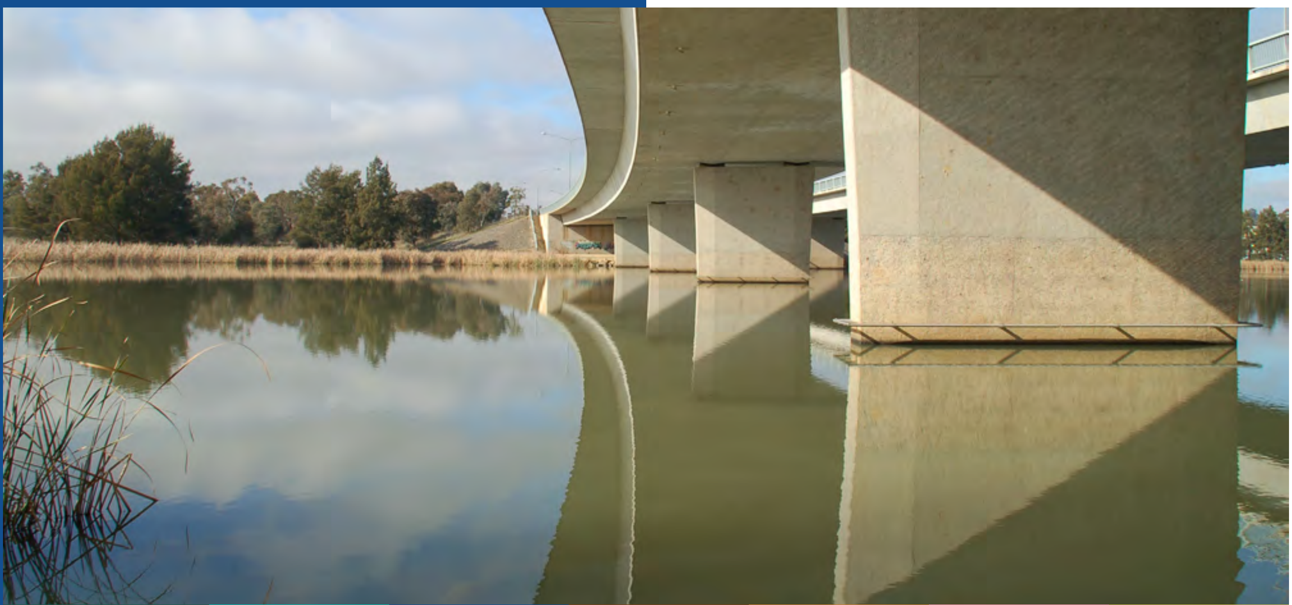
Several critical future issues with management of the urban lakes and waterways are highlighted. Specifically, climate change is the most significant environmental challenge for the management of water quality, impacting runoff patterns and stream flows. Further potential threats include changes to the existing urban footprint to support a growth in ACT population, and required infrastructure changes (such as upgrading sewage treatment plants).

The Investigation sets out 12 recommendations to the ACT Government around urban water quality management in the ACT. Before doing so, it notes numerous preceding reports and recommendations to the ACT Government on water quality issues. Outstanding and repeated recommendations must be revisited and redressed.

*Lake Ginninderra. Source: Fiona Dyer*

# 1

# Introduction



*Ginninderra Drive Bridge in Lake Ginninderra.*
*Source:Fiona Dyer*

## Contents

## 1.1 Purpose of this Investigation

This Investigation into the state of the lakes and waterways in the ACT was directed under section 12(1)(b) of the *Commissioner for Sustainability and the Environment Act 1993*, by Rebecca Vassarotti, Minister for the Environment, on 3 March 2021. The need for the Investigation was identified in the ACT State of the Environment 2019 (SoE)[1] report under *Recommendation 27: Institute a State of the Canberra Lakes reporting initiative, commencing in 2020*.

The recommendation was made in response to the identified water quality and aquatic ecosystem health issues impacting on Canberra's lakes and waterways. Concern about poor water quality has been particularly evident in recent years with extended periods of blue-green (cyanobacteria) algal blooms and high levels of faecal coliform bacteria (enterococci) preventing the community from using Canberra's lakes for recreation during summer for primary contact recreational purposes.

It is necessary to begin this report with a note about the long-standing culture of examination of the Territory's lakes and waterways. An investigation into the state of Lake Burley Griffin was undertaken in 2012 by the Office of the Commissioner for Sustainability and the Environment (OCSE) – *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*.[2] In the years since that 2012 report, numerous other reports, investigation and reviews have been commissioned by ACT Government to inform the development of management plans and policies. However, many of the recommendations arising from these processes remain outstanding or ongoing, and the same management and investment opportunities have been repeatedly identified over the years (see Tables 2.1 to 2.4 in **section 2.4**). In many instances, progress on report recommendations is not included in various annual reports, and the formal status of recommendations remains unclear. Without focused consideration of outstanding actions and existing recommendations yet to be implemented, outcomes to tangibly improve water quality in the Territory will likely be limited.

The 2012 report focussed entirely on Lake Burley Griffin and associated waterways, thus a much narrower geographic scope. The current Investigation, however, includes all Canberra lakes and ponds, as well as the major waterways that flow through the urbanised area. This updates the ACT Government and community on the health and management of the urban lakes and waterways in the ACT. This knowledge is critical at a time of increasing pressures on our waters from climate change, population growth and urban development. The findings of this Investigation have been used to develop recommendations to improve water health in the future (see **Chapter 13: Conclusions and Recommendations**).

1. Office of the Commissioner for Sustainability and the Environment, 2019. *ACT State of the Environment 2019. Canberra*.
2. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.

## 1.2 Scope and limitations of this Investigation

The Investigation was required to evaluate and provide recommendations to the Minister for the Environment on four key areas:

1. The condition of Canberra's main lakes and waterways and trends in recreational and environmental water quality, and ecological condition and function.

2. The effectiveness of key ACT Government management actions and strategies to protect Canberra's lakes, and waterways.

3. The ACT Government's monitoring, evaluation and reporting processes relevant to Canberra's lakes and waterways.

4. The role of community and stakeholders in managing water quality and ecological health.

In addition to the above, OCSE has included content on water in Ngunnawal Country (see **Chapter 3: Ngunnawal cultural water**). This examines the need to incorporate assessments of ecosystem health by Traditional Owners, and to consider and implement Traditional aquatic management techniques. OCSE has also made recommendations to improve the inclusion of Ngunnawal People's knowledge in the management of ACT waters. The full terms of reference can be found in **Appendix 1** .

The objective of this State of the Lakes and Waterways Investigation is to assess waters that are within, or flow through, the ACT's urban area. The study area is therefore limited to the following waters in the ACT (see Figure 1.1):

- Lake Burley Griffin, Lake Ginninderra and Lake Tuggeranong
- waterways that flow through the urban area and into the Murrumbidgee River, including the Molonglo River and tributaries, Ginninderra Creek, Tuggeranong Creek, Sullivans Creek and
- urban ponds and wetlands.

Excluded are waterways and associated wetlands that do not flow through the urban area. This includes those waters in parks and reserves west of the Murrumbidgee River (Cotter, Gudgenby, Naas and Paddys Rivers), drinking water reservoirs, water supply catchments, and the Murrumbidgee River itself.

3. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.

There are several limitations that should be noted:

- This Investigation does not revisit the level of detail and depth of research and analysis provided in the 2012 report on the state of Lake Burley Griffin. That report was exclusively focussed on Lake Burley Griffin and with the expanded focus of this Investigation, it was not possible to provide that same level of detail. Nevertheless, this Investigation still provides a comprehensive assessment of the lake's condition and a follow up assessment of the main findings presented in the 2012 report. The main findings of this report are detailed in **Appendix 2**.
- Although flood mitigation is a critical function of Canberra's urban waters, this value is not within the scope of this particular Investigation, therefore it is not addressed here (see section **2.2 Constructed urban lakes and waterways** for an explanation of purpose of lakes and ponds).
- The Investigation does not assess the economic impact of poor water quality in urban waters. For example, the costs of recreational lake closures.
- Although this Investigation discusses actions for improving the monitoring, evaluation, and reporting for urban waters, it is beyond the capacity of this work to provide specific detail on what these changes should be. For example, selection of monitoring sites to improve water quality coverage or the development of indicators to improve reporting accuracy and consistency. Such detail requires the involvement of water experts and that it be undertaken with input from all relevant stakeholders.

*Common Blue Damselfly. Source: Ryan Colley*

## 1.3. How to use this report

It is beyond the capacity of this Investigation to provide the solutions to all of the issues impacting on urban water. Instead, the findings, recommendations and key actions presented provide the impetus and guidance for further work to improve the management and health of Canberra's urban waters.
It is important that this report is viewed together with the full reports commissioned to provide the basis for the analysis presented.

These are:

- *State of the ACT's Lakes and Waterways 2011–2021* by the Centre of Applied Water Science, University of Canberra.
- *ACT Waterways Policy Review* by Alluvium Consulting.

In tandem, these comprehensive reports provide in-depth analysis and extensive coverage of both the condition of urban waters and their management. These reports are available on the Office of the Commissioner for Sustainability and the Environment website (www.envcomm.act.gov.au).

Throughout the report, the terms emphasised in bold are defined glossary terms and a definition is provided in the footer of that page. Key Actions are provided throughout as focused steps to address identified issues.

*Latham Snipe. Source: Ryan Colley*

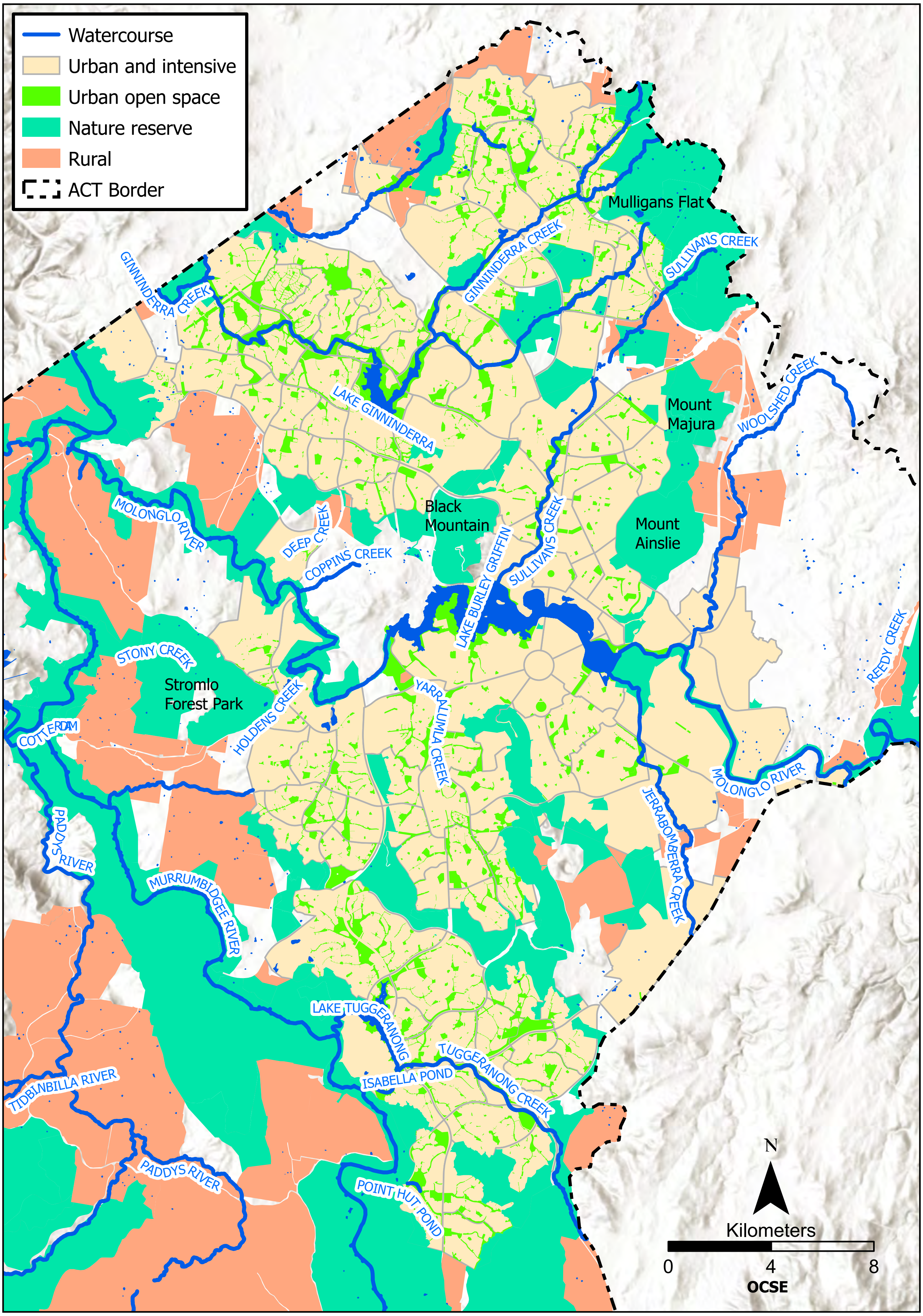
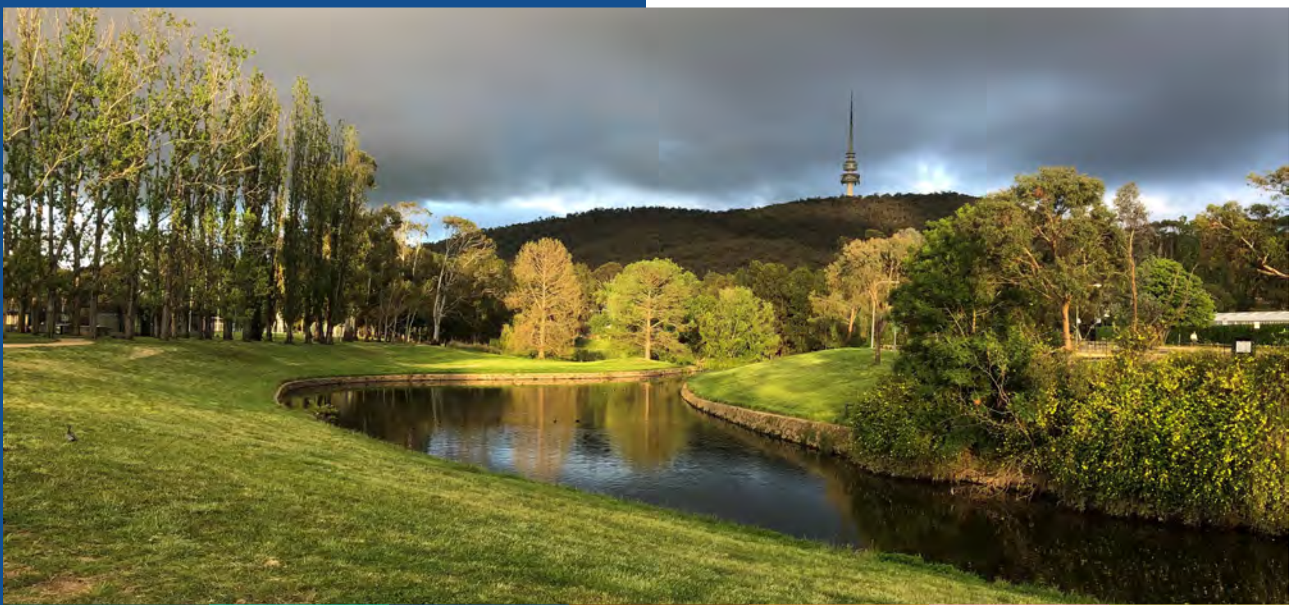



**Figure 1.1 :** Investigation area showing an overview of the urban lakes and waterways of the ACT.

**Data sourced from:** ACT Government, background data from ESRI.

# 2 Background to Canberra's urban lakes and waterways



*Sullivan's Creek. Source: Ben Dyer*

## Contents

## 2.1 Lakes and waterways of Ngunnawal Country

*Daramulan created Ngunnawal Country giving us our spirituality, culture, lore and law, customs and traditions. We walk as one with one foot in the past and one foot in the present. Maliyan flew across Ngunnawal Country spreading her wings and laying her eggs which are the large rock formations across Country. As Maliyan flew she created the mountains, the waterways, the trees, the animals, the fish, the valleys, the pathways and Songlines.*

*The waterways on Ngunnawal Country have sustained all life including our people, plants and animals. The waterways formed part of our Songlines. Songlines are the Ngunnawal memory code that gives us information from the landscape to tell the stories of vital knowledges, cultural values and wisdom. The Songlines are a potent form of cultural memory and the passing on of stories to future generations. The waterways are all connected to each other through the Ngunnawal people informing ceremony, language, song, dance, art and the oral tradition of storylines weaving our history and present with each other and our environment.*

The Ngunnawal people are the ACT region's first inhabitants, having lived here for more than 25,000 years. Ngunnawal people's cultural roots extend to caring for their river Country through links to the Murrumbidgee, Molonglo and Cotter Rivers, each of which are part of the broader Murray-Darling Basin. Ngunnawal Country is situated in the northern part of the Snowy Mountains which provides strong links and pathways to the coast from the mountains. These water courses and byways follow and represent Songlines and Dreamings here in the south-east, just as they do in other parts of the country.

## 2.2 Constructed urban lakes and waterways

Canberra is now the largest urban centre within the Murray–Darling Basin. All waters that pass through Canberra's urban area flow into the Murrumbidgee River. This means that the management of water quality is not only vital for the ACT itself but also for the downstream ecosystems, agricultural industries, and communities of the Murray–Darling Basin.

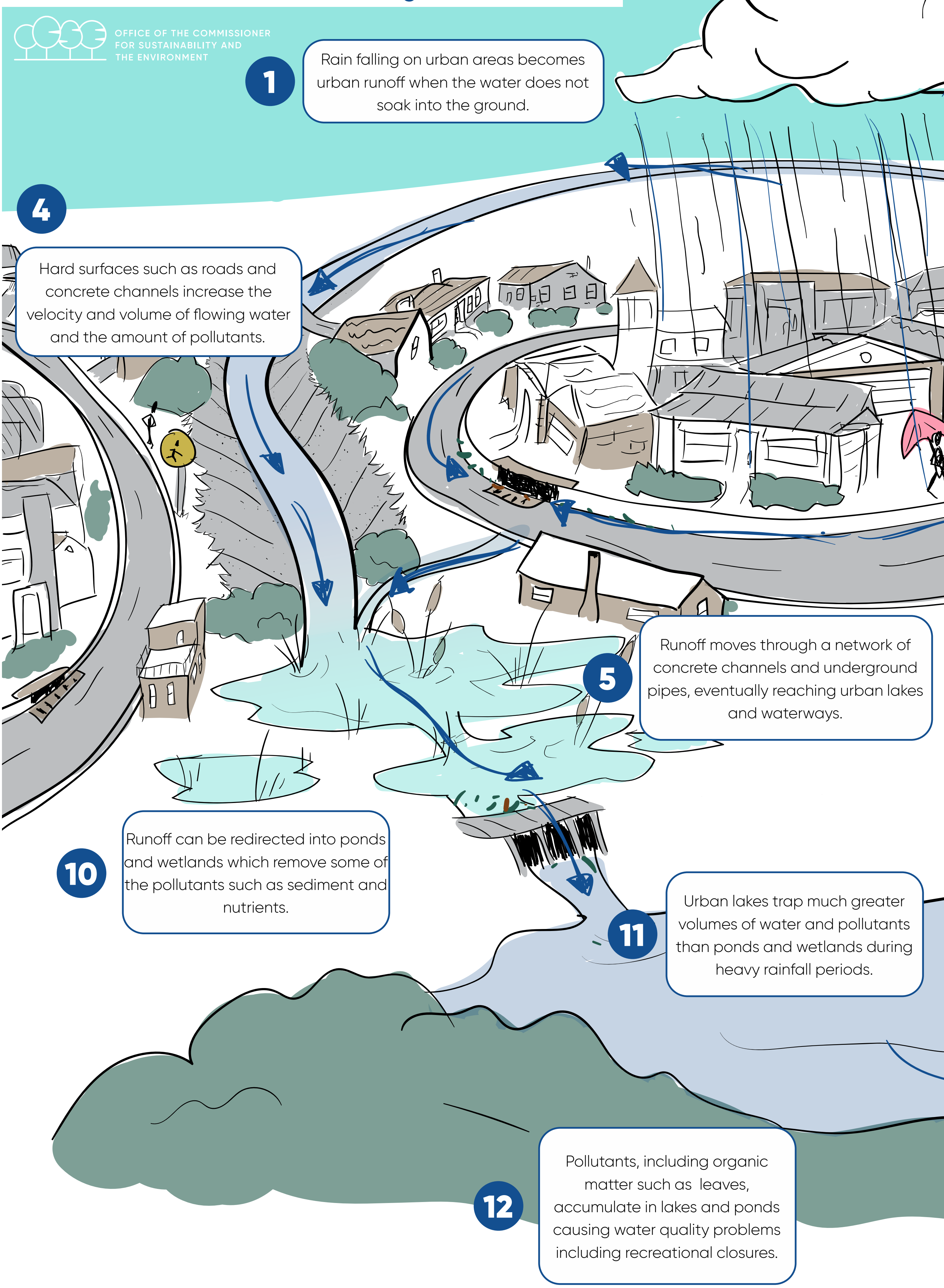
Canberra's urban waters are those rivers, creeks, lakes, ponds and wetlands that occur in urban environments or receive stormwater runoff from an urbanised catchment. The constructed lakes in the ACT are Lake Burley Griffin, Lake Ginninderra and Lake Tuggeranong. Constructed ponds include Gungahlin, Yerrabi, Point Hut, West Belconnen, Weston Creek, Isabella and the upper and lower Stranger Ponds. There are 198 constructed urban ponds and wetlands in the ACT with a combined surface area of more than 216 hectares.[4] Rivers and creeks that flow through Canberra's urban area include the Molonglo River, Ginninderra Creek, Tuggeranong Creek and Sullivans Creek (see Figure 1.1). For more detailed information on Canberra's urban lakes and waterways see **Chapter 5: The condition of urban lakes and waterways**.

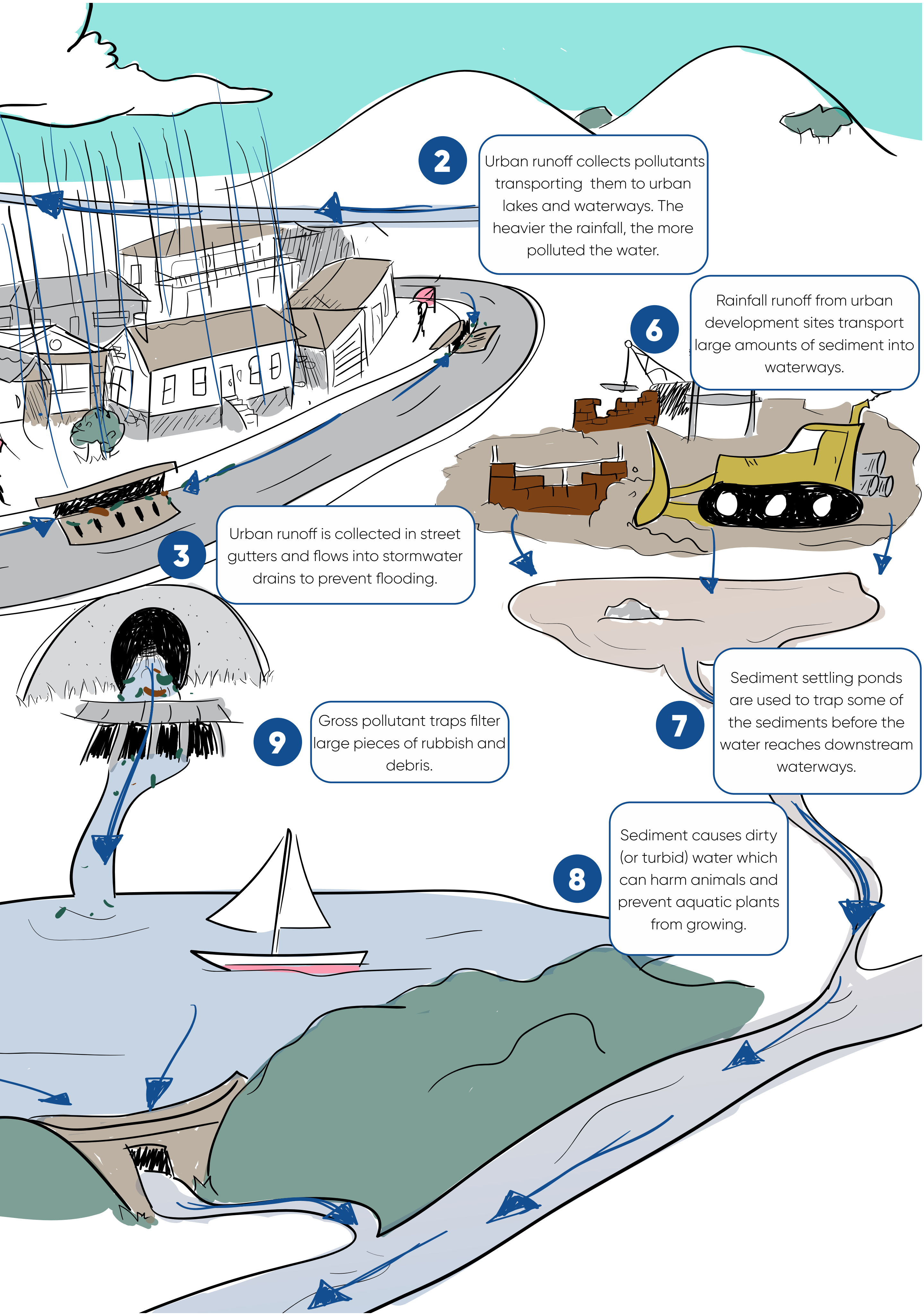
Canberra's urban lakes, and many of the waterways, were specifically constructed or modified to manage the impacts of urban runoff. This has resulted in an engineered waterway system that has significantly reduced the habitat and landscape values through physical modification of the waterway and removal of vegetation. The physical form of urban creeks is often characterised by unmodified, but mostly significantly **disturbed**,[5] sections in rural upper reaches that become highly modified concrete channels in denser urbanised areas, and concrete swales with grassy banks in other reaches. There is now far more diversity in Canberra's constructed waters with different types of treatment systems such as ponds, wetlands and rain gardens. These additions to the waterways provide far more environmental and community benefits. However, the legacy of historical modifications continues to impact the health of Canberra's waterways.

4. Dyer, F., et al., 2022. *State of the ACT's Lakes and Waterways 2011–2021: a technical review*. A report to the ACT Office of the Commissioner for the Environment and Sustainability by the Centre for Applied Water Science at the University of Canberra.
5. For example, loss of riparian vegetation, channel erosion, high levels of sedimentation, stream bank collapse, and large inputs of diffuse source pollution including nutrients and suspended solids.

*Molonglo River. Source: Ryan Colley*

# Urban stormwater runoff and management in the ACT




2
Urban runoff collects pollutants transporting them to urban lakes and waterways. The heavier the rainfall, the more polluted the water.
6
Rainfall runoff from urban development sites transport large amounts of sediment into waterways.
3
Urban runoff is collected in street gutters and flows into stormwater drains to prevent flooding.
7
Sediment settling ponds are used to trap some of the sediments before the water reaches downstream waterways.
9
Gross pollutant traps filter large pieces of rubbish and debris.
8
Sediment causes dirty (or turbid) water which can harm animals and prevent aquatic plants from growing.

### 2.2.1 About Lake Burley Griffin

Lake Burley Griffin is an artificial lake in the heart of Canberra and the centrepiece of Walter Burley Griffin and Marion Mahony Griffin's design for Canberra. The lake was created by the construction of Scrivener Dam on the Molonglo River and was first filled in 1964. Lake Burley Griffin is considered an essential part of Canberra's character and non-First Nations heritage, and is highly valued for its recreational use and aesthetic qualities. The lake represents a focal point for the Canberra community, visitors and water-based commercial services with a significant number of national institutions and attractions located on or near its shores. Because the lake is an important inland water feature, there is growing community expectation for improved water quality to ensure recreational access, protect the health and safety of users, maintain ornamental and aesthetic values, and support commercial functions.

Apart from its aesthetic and recreation benefits, Lake Burley Griffin has important roles in minimising flood risk by attenuating flood peaks, and in water quality management through the capture of pollutants. The removal of pollutants is vital to improve the quality of water flowing downstream of Canberra and to minimise impacts on the Lower Molonglo and Murrumbidgee Rivers. This means that Lake Burley Griffin is an integral part of water quality management in the Murray-Darling Basin, Australia's most significant drainage basin. Lake Burley Griffin may also provide water for local irrigation of public and private open space, including the Australian National Botanic Gardens.

Lake Burley Griffin is managed by the National Capital Authority (NCA) on behalf of the Commonwealth of Australia, which has responsibility for the lake itself and some of the foreshore area. However, its management responsibilities do not include catchment areas of the lake other than those on National Land. The ACT and NSW Governments (including the Queanbeyan-Palerang and Cooma-Monaro regional councils) are responsible for managing the vast majority of the catchment areas that drain into Lake Burley Griffin.

More information on Lake Burley Griffin can be found in the 2012 *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*.[6]

6. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.

*Lake Burley Griffin. Source: Ryan Colley*

## Lake Burley Griffin key facts

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**Lake Burley Griffin**

- Reduces the risk of flood.
- Captures pollutants to protect downstream waters, including the Murrumbidgee River.
- Highly valued for recreational use and aesthetic qualities.

**Yarramundi Reach**
reedbeds provide valuable waterbird habitat.

**Sullivan's Creek**
can contribute over 15% of the total inflows in dry years.

Foreshores support endangered plant and animal species including Button Wrinklewort and Striped Legless Lizard.

**Scrivener Dam**
controls outflows to maintain the lake at a constant level or to refill the lake after drought periods.

Urban development is increasing in the catchment degrading water pollution.

**Lake Burley Griffin**

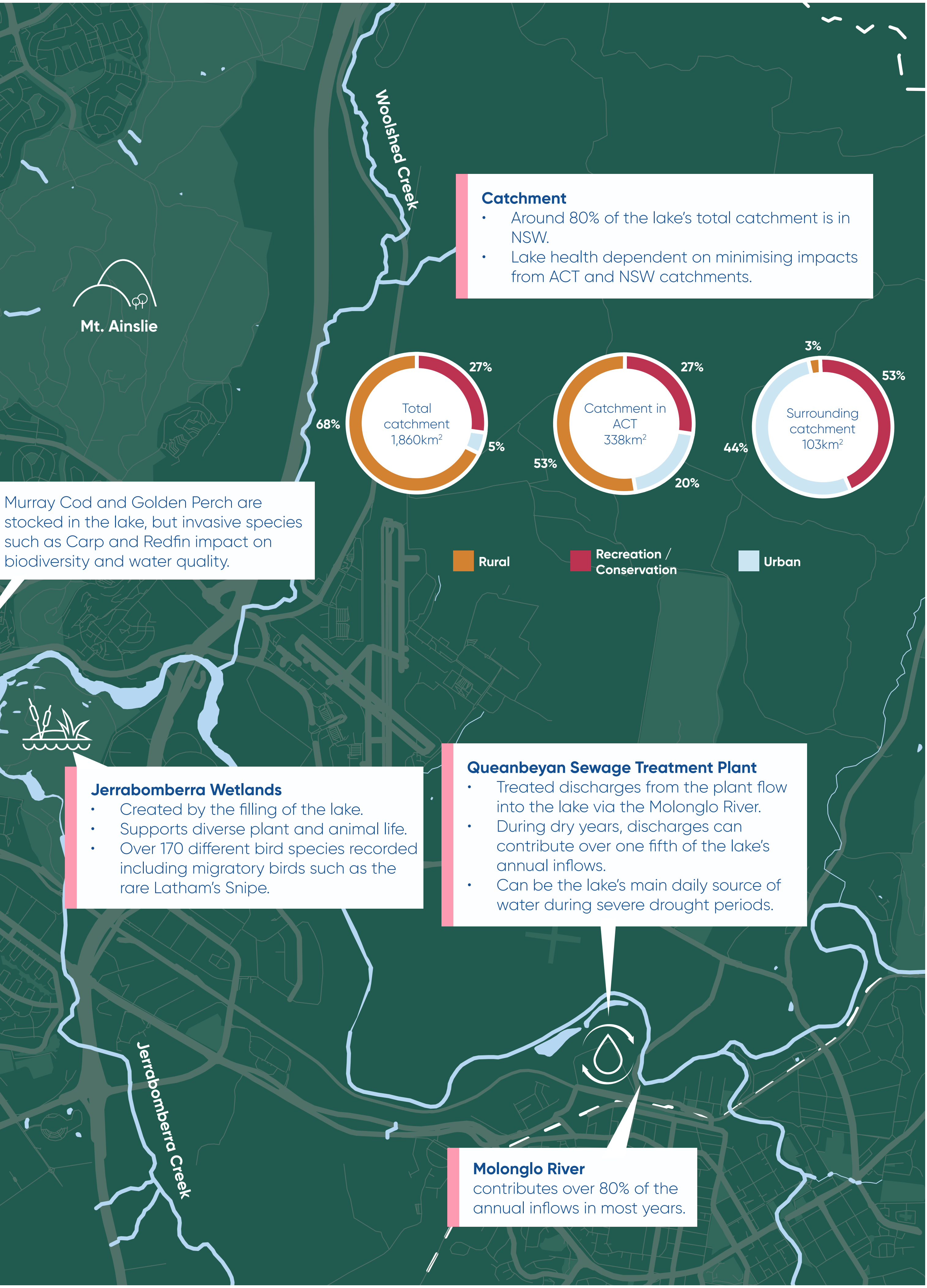
- First filled in 1964.
- Total surface area of 6.64 km$^2$.
- Average depth 4 metres.
- Maximum depth 18 metres.

**Annual inflows, 2010 to 2021**

- Lowest of 10,400 ML in 2019.
- Highest of 470,000 ML in 2021.
- Most water comes from the Molonglo River.

**Management**

- National Capital Authority manages the Lake, but just 38% of the shoreline.
- ACT Government manages 57% of the shoreline and most of the catchment within the ACT.




**Catchment**

- Around 80% of the lake's total catchment is in NSW.
- Lake health dependent on minimising impacts from ACT and NSW catchments.

Murray Cod and Golden Perch are stocked in the lake, but invasive species such as Carp and Redfin impact on biodiversity and water quality.

**Jerrabomberra Wetlands**

- Created by the filling of the lake.
- Supports diverse plant and animal life.
- Over 170 different bird species recorded including migratory birds such as the rare Latham's Snipe.

**Queanbeyan Sewage Treatment Plant**

- Treated discharges from the plant flow into the lake via the Molonglo River.
- During dry years, discharges can contribute over one fifth of the lake's annual inflows.
- Can be the lake's main daily source of water during severe drought periods.

**Molonglo River**
contributes over 80% of the annual inflows in most years.

### 2.2.2 About Lake Tuggeranong

Lake Tuggeranong is an artificial lake in the south of Canberra, adjacent to the Tuggeranong Town Centre. Created by the damming of Tuggeranong Creek in 1987, it was filled in 1990, coinciding with the urban development of the area. Lake Tuggeranong is surrounded by a commercial district to the west, which has seen high density urban infill occurring since 2019. On the eastern side of the lake there is a mix of urban dwellings and recreational spaces.

Lake Tuggeranong forms part of the Upper Murrumbidgee drinking water supply catchment for Canberra and Queanbeyan. Water abstraction can occur downstream of the Tuggeranong Creek confluence with the Murrumbidgee River at the Cotter Pumping Station near Casuarina Sands for treatment at Stromlo Water Treatment Plant.

Lake Tuggeranong was originally designed as a settling basin to trap pollutants from the surrounding urban catchments and improve the water quality entering the Murrumbidgee River. It provides water quality improvement to stormwater discharge from the local catchments and urban centres. The lake also has a role in flood mitigation.

The lake provides a space for recreation, exercise, play, and conservation for the Tuggeranong community. Primary contact recreation occurs at a number of beaches around the lake. The character, amenity and aesthetics of the lake, its foreshores and its recreational uses are greatly valued by the Tuggeranong community.

The ACT Government is responsible for the management of Lake Tuggeranong, the foreshore areas and the surrounding catchments. The approach to managing the lake is documented in the *Canberra Urban Lakes and Ponds Land Management Plan*.[7] The plan identifies the recreational, cultural and management values associated with Lake Tuggeranong.

7. Environment, Planning and Sustainable Development Directorate, 2022. *Canberra Urban Lakes and Ponds Land Management Plan*. ACT Government, Canberra.

## Lake Tuggeranong key facts

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**Catchment**
- Total catchment area of 61 km$^2$, mostly in the ACT.
- Land use is 50% urban, 30% conservation and recreation, and 20% rural lands (mainly in NSW).
- Most of the catchment surrounding the lake is urbanised.
- The lake's small size in comparison to its catchment area increases the risk of poor water quality.

**Values**
- Traps pollutants to improve the quality of water entering the Murrumbidgee River.
- Reduces the risk of flood.
- Highly valued for recreational opportunities and aesthetic qualities.

**Improving water quality**
- $30 million provided under the 2014 Healthy Waterways Program to improve water quality.
- Funding used to establish water sensitive urban design measures.

**Urban development** is increasing in the catchment further degrading water quality.

**Outflows** controlled to maintain the lake at a constant level or to refill the lake after drought periods.

Murray Cod and Golden Perch are stocked in the lake, but invasive species such as Carp and Redfin impact on biodiversity and water quality.

Outflows from Lake Tuggeranong are received by Tuggeranong Creek which then flows into the Murrumbidgee River approximately 2km downstream.

Water pollution control ponds, such as the Isabella and Stranger Ponds, were constructed to help improve water quality.

**Lake Tuggeranong**
- Created by the damming of Tuggeranong Creek in 1987.
- Surface area of 0.57 km$^2$.
- Maximum depth 13 metres.

**Inflows**
- Main inflows are Tuggeranong Creek, Village Creek, Kambah Creek, and Oxley inflow. Inflow volumes are not measured.

**Management**
- ACT Government manages the lake and its catchment.

### 2.2.3 About Lake Ginninderra

Lake Ginninderra was formed in 1974 by the damming of Ginninderra Creek. The lake forms a u-shape with a central peninsula and two main parks on the eastern and western sides of the lake.

Lake Ginninderra was designed to form a scenic focus for the Belconnen Town Centre. It provides visual and recreational amenity, with primary contact recreation occurring at a number of beaches. The character, amenity and aesthetics of Lake Ginninderra, its foreshores, and its recreational uses are greatly valued by the Belconnen community.

The lake provides water quality improvement to stormwater discharge from the local catchments and urban centres. It functions as a settling basin to trap pollutants and improve the water quality in the downstream Ginninderra Creek and Murrumbidgee River. The lake also has a role in flood mitigation.

Ginninderra has received far less attention than the other lakes in the ACT with little in the way of published research. This is likely due to the lake historically having far fewer significant water quality issues and recreational closures.

The ACT Government is responsible for managing Lake Ginninderra, the foreshore areas and the surrounding catchments. The approach to the lake's management is documented in the *Canberra Urban Lakes and Ponds Land Management Plan*.[8] The plan identifies the recreational, cultural and management values associated with Lake Ginninderra.

8. Ibid.

## Lake Ginninderra key facts

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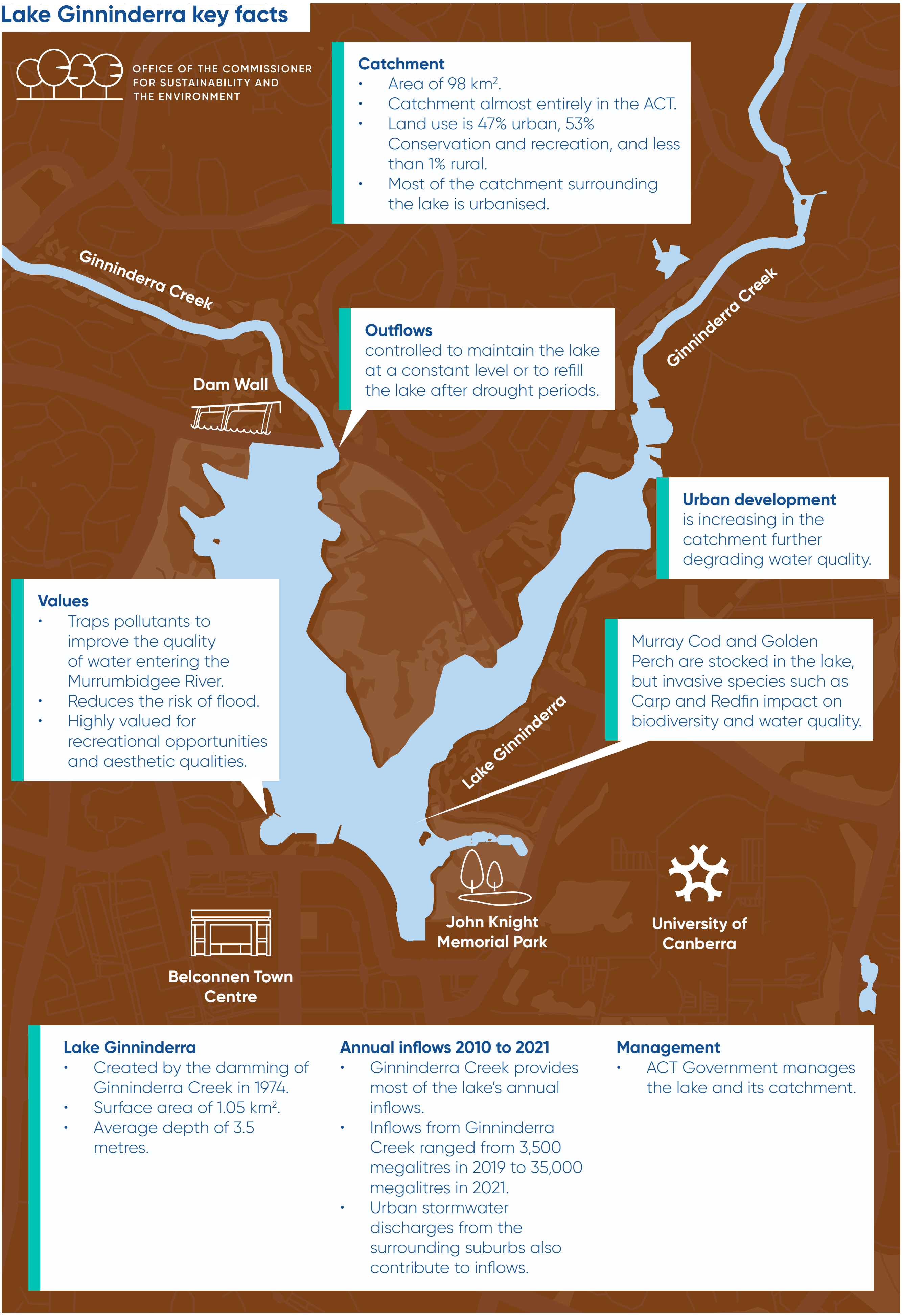


**Catchment**

- Area of 98 km$^2$.
- Catchment almost entirely in the ACT.
- Land use is 47% urban, 53% Conservation and recreation, and less than 1% rural.
- Most of the catchment surrounding the lake is urbanised.

**Outflows**
controlled to maintain the lake at a constant level or to refill the lake after drought periods.

**Urban development**
is increasing in the catchment further degrading water quality.

**Values**

- Traps pollutants to improve the quality of water entering the Murrumbidgee River.
- Reduces the risk of flood.
- Highly valued for recreational opportunities and aesthetic qualities.

Murray Cod and Golden Perch are stocked in the lake, but invasive species such as Carp and Redfin impact on biodiversity and water quality.

**Lake Ginninderra**

- Created by the damming of Ginninderra Creek in 1974.
- Surface area of 1.05 km$^2$.
- Average depth of 3.5 metres.

**Annual inflows 2010 to 2021**

- Ginninderra Creek provides most of the lake's annual inflows.
- Inflows from Ginninderra Creek ranged from 3,500 megalitres in 2019 to 35,000 megalitres in 2021.
- Urban stormwater discharges from the surrounding suburbs also contribute to inflows.

**Management**

- ACT Government manages the lake and its catchment.

### 2.2.4 About the Molonglo River

The Molonglo River played a pivotal role in the siting of Canberra and is dammed to provide the National Capital with its major water feature, Lake Burley Griffin. The Molonglo River is therefore significant as the main source of water for Lake Burley Griffin. Additionally, the river itself provides important visual and recreational amenity for the Canberra community and provides habitat for aquatic and terrestrial species.

The upper and lower sections of the Molonglo River are vastly different in terms of the character of the river channel, and the surrounding vegetation. The lower Molonglo River section is the site of the Molonglo River Reserve which surrounds the river area and has been subject to significant vegetation restoration and biodiversity habitat enhancements. The reserve provides habitat for some threatened flora and fauna species and vegetation communities.

There are also significant differences between the pressures on the lower and upper Molonglo River sections. The upper section is mainly influenced by rural land use impacts in NSW, and the discharges from the Queanbeyan Sewage Treatment Plant — although urban impacts in NSW are also increasing. The lower Molonglo River is mainly impacted by the increase in urban areas and the extensive urban development being undertaken in the Molonglo Valley.

Whilst the major recreational focus for the Molonglo River has been Lake Burley Griffin, urban development in the Molonglo Valley has seen growing community interest on the river corridor between Scrivener Dam and the Murrumbidgee River situated in the Molonglo River Reserve. The river corridor is seen as an important recreation landscape feature for the growing population in the Molonglo Valley. The future recreational and aesthetic value of the lower Molonglo River environment will be dependent on the maintenance of water quality and ecosystem health, including the **riparian areas**.[9]

### 2.2.5 About Tuggeranong Creek

Tuggeranong Creek is a partly perennial creek that begins near the ACT and NSW border east of the Monaro Highway, flowing into Lake Tuggeranong before reaching the Murrumbidgee River. Tuggeranong Creek was dammed in 1987 to create Lake Tuggeranong. The creek, its catchment and riparian areas are all managed by the ACT Government.

Much of Tuggeranong Creek is considered to be in a severely degraded condition. Upstream of Lake Tuggeranong, the creek and its major tributaries are characterised by mostly concrete lined channels, making them almost devoid of ecosystem value due to the highly engineered nature of the waterway. The riparian vegetation is also highly degraded, being predominantly made up of invasive weed species and mown grass. In addition, Waterwatch surveys report that the creek is often full of rubbish which detracts from any possible visual amenity provided by the drains.[10] Downstream of Lake Tuggeranong, the creek has a more natural form and is fringed by reeds, grassed slopes and casuarina.

9. Zones located alongside watercourses such as rivers and lakes, that support distinct biodiversity communities, prevent erosion and filter water.
10. O'Reilly, W., et al., 2021. *Catchment Health Indicator Program: Report Card 2020*. Upper Murrumbidgee Waterwatch, Canberra.

Because a substantial portion of Tuggeranong Creek and its tributaries upstream of Lake Tuggeranong are concrete lined channels, they have offered little recreational or visual amenity to the community. Their value has been their functionality to move stormwater flows efficiently and effectively away from urban areas. Consequently, Tuggeranong Creek's water quality and aquatic ecosystem health upstream of the lake has rarely been of concern for water managers and the community in the past. However, concern over water quality is growing, driven by the poor condition of Lake Tuggeranong and the impacts on the Tuggeranong community (see section **6.2 Lake Tuggeranong**). It is now acknowledged that to improve the condition of Lake Tuggeranong, the water quality and ecosystem health of Tuggeranong Creek and its tributaries must be addressed.

### 2.2.6 About Ginninderra Creek

Ginninderra Creek is an important stream corridor providing a range of aesthetic and recreational values to Gungahlin and Belconnen. It flows through numerous public parks providing a focus for community recreation and there are popular pedestrian and bike paths alongside significant portions of the creek. The last few kilometres of the creek become a series of falls through Ginninderra Gorge, a spectacular and reasonably well-preserved remnant natural area that is of substantial interest to the community. Ginninderra Creek, its catchment and riparian areas are managed by the ACT Government.

There are several major impoundments in the Ginninderra Creek catchment. Gungahlin Pond and Lake Ginninderra are on the main stem of Ginninderra Creek. Yerrabi Pond is on the eastern arm of Ginninderra Creek, and Valley Pond and Mulligan's Flat Dam are on smaller drainage lines. With the exception of Mulligan's Flat Dam, these impoundments were constructed as part of the water sensitive urban design infrastructure in the catchment and provide both recreational opportunities and potential water quality improvements in the creek.

### 2.2.7 About Sullivans Creek

Sullivans Creek provides a range of aesthetic and recreational values to the inner northern suburbs of Canberra. The creek corridor is an important pathway with a key bike path travelling alongside the floodway to the Australian National University (ANU) and the city centre. Sections of the creek corridor provide ornamental and aesthetically pleasing scenery and the suite of wetlands within the catchment are key focal points for recreation. For reaches within the ANU, the creek is a focal point for the campus and has undergone some significant modifications as a result of the university's land developments. Sullivans Creek flows into Lake Burley Griffin and can impact on the recreational and aesthetic values of the lake, as well as its aquatic health. Sullivans Creek and its riparian areas are managed by the ACT Government and the ANU.

The upper half of Sullivans Creek flows through reserve and farmland with eroded and incised channels caused by early land clearing. There are small farm dams on the creek and tributaries that act to slow the flow of water. These upper reaches of the creek are vulnerable to further erosion and channel degradation if water flows were to increase as a consequence of urban development in the area. Downstream of Flemington Road, the creek is a concrete stormwater channel, designed to transport stormwater more efficiently. As the creek flows through ANU, it has been landscaped to be a series of ponds connected by grassed channels.

The ACT Government has installed a system of retrofitted wetlands and ponds across the Sullivans Creek catchment to improve water quality, particularly for inflows to Lake Burley Griffin, and to reduce the impacts of a growing population. These wetlands include the Flemington ponds, David St O'Connor Wetland, Banksia St O'Connor Wetland, Hawdon St Dickson Wetland, Goodwin St Lyneham Wetland. The Inner North Reticulation System is a stormwater harvesting and managed aquifer recharge system associated with some of the Sullivans Creek catchment ponds and wetlands. This system uses the water collected for the irrigation of public green spaces in the catchment.

### 2.2.8 About Canberra's urban ponds and wetlands

Urban ponds and wetlands have been established in Canberra as part of the city's water sensitive urban design infrastructure and as a critical part of the region's green infrastructure. There are currently 198 constructed urban ponds and wetlands in the ACT with a combined surface area of more than 216 ha. They are managed by the ACT Government.

The main function of these constructed urban ponds and wetlands is to maintain and enhance the water quality of urban stormwater and runoff by removing pollutants such as nitrogen, phosphorus, and suspended sediments. This provides downstream benefits to the ACT's lakes as well as the Molonglo and Murrumbidgee Rivers.

Ponds and wetlands mitigate flooding during storm events by capturing runoff from surrounding urban catchments. For example, the Dickson Wetland, and the Lyneham and Flemington Ponds play a significant role in reducing peak flows which in turn provides flood protection for surrounding and downstream residents.

Although the urban ponds and wetlands are primarily designed to improve water quality and reduce flooding, they also have many other values. The Canberra Urban Lakes and Ponds Land Management Plan states that urban lakes and ponds should:

> *Enrich local communities through the aesthetic, recreational, sport, tourism and ecological values of lakes and ponds, and to provide opportunities for people to be involved in their use, care and management.*[11]

This means that as well as delivering water quality benefits, urban ponds should provide ecosystem services including enhancing biodiversity, locations that are aesthetically pleasing, recreational opportunities, and sites for community environmental management. Given the wide range of values, it is unlikely that the community considers the primary function of water quality management to be the most important value.

11. Environment, Planning and Sustainable Development Directorate, 2022. *Canberra Urban Lakes and Ponds Land Management Plan*. ACT Government, Canberra.

*Yarralumla Creek. Source: Fiona Dyer*

## 2.3 Evolving urban water management

Stormwater treatment principles have evolved significantly over the decades, and stormwater treatment systems constructed through the ACT over these years reflect an evolving approach to urban water management. Further detail is provided in **Chapter 10: Management and Governance of urban lakes and waterways**.

In the 1970s the focus of urban stormwater management was on drainage. Concrete channels were a common approach to move stormwater rapidly and efficiently away from urban areas into receiving waters. However, they also delivered pollutants efficiently and directly into receiving waters and the impacts of this practice were becoming evident. To mitigate this, the first gross pollutant traps were constructed in Canberra in the 1970s.

By the 2000s, Water Sensitive Urban Design (WSUD) became an important concept in the ACT's policies and its principles were adopted as part of the ACT's strategic planning. In 2002, the ACT Legislative Assembly passed a motion about water management, including an agreement that the water leaving the ACT via the Murrumbidgee River should be of no less quality than the water flowing into the ACT. The 2004 "Think Water Act Water" strategy included an objective to 'facilitate the incorporation of water sensitive urban design principles into the urban, commercial and industrial development'.

The ACT WSUD Code was published in 2009 and requires new developments to meet mandatory stormwater pollutant load reduction targets. The code also encourages stormwater treatment closer to the source, with treatment systems distributed throughout an estate, as well as the inclusion of on-block stormwater treatment measures. This reduced reliance on a single large lake or pond at the bottom of a catchment as the main stormwater treatment measure.

Stormwater assets constructed in more recent years include retrofit projects and more than 20 new wetlands, ponds and bioretention systems built under the ACT Healthy Waterways Program.

## 2.4 Statutory reporting on urban lakes and waterways

As noted in the introduction to this report, the ACT Government has a strong tradition of investigating and reporting on its urban waterways. This section presents a selection of the recommendations which are relevant to this Investigation that have been made since the Commissioner's 2012 Report on the State of the Watercourses and Catchments for Lake Burley Griffin. A number of these recommendations remain highly relevant, including some that have been assessed as complete. The intent of this section is to illustrate that repeated reporting and recommendations have highlighted many of the same issues and concerns, which are identified again in this current Investigation.

## Water sensitive urban design

Water Sensitive Urban Design (WSUD) is an approach to urban planning and design that aims to integrate the management of the water cycle, including stormwater, into the urban development process. WSUD includes the construction of wetlands and ponds, which together with other measures such as rain gardens and permeable paving, improve water quality and reduce the risk of flooding.

Urban wetlands, ponds and other WSUD measures improve water quality by reducing the velocity of stormwater, allowing contaminants to settle and removing nutrients through biogeochemical processes. Vegetation associated with WSUD such as wetland **macrophytes**[12] capture pollutants attached to sediment, particularly phosphorous and nitrogen, removing these contaminants before the water is discharged downstream.

Benefits of WSUD include:

- protection of downstream ecological systems by improving water quality from urban waterways
- improved flood protection
- capture of stormwater for irrigating urban green spaces
- retention of water into the landscape
- recharge of the groundwater system
- supporting more streetscape vegetation to help mitigate the urban heat island effect and cool the landscape on hot summer days
- creation of habitat for plants and animals, and
- social benefits such as places for recreation and volunteering, and opportunities for education.

WSUD concepts are now widely adopted and implemented in Canberra and are an important consideration for the design of new developments. However, the effectiveness of WSUD measures is dependent on many factors including the quality of planning, design and construction of the systems, and the ongoing maintenance of the infrastructure developed. This has meant that the performance of Canberra's WSUD systems are highly variable, particularly in terms of meeting objectives for water quality and providing suitable environments for social amenity.

The effectiveness and management of Canberra's WSUD systems are discussed in more detail in **11.6 Effectiveness of Water Sensitive Urban Design measures**.

12. Aquatic plants adapted to live near or in water. They can provide habitat and food for animals, and absorb nutrients from sediments.

### Table 2.1. Summary of progress against ACT State of the Environment Report 2019

| Recommendation | Public government response/evidence |
|---|---|
| **28: Produce an annual recreational water quality report that includes monitoring results, investigations into the main sources of pollutants, recommended actions to improve water quality, and assessments of management effectiveness.** | EPSDD: Environment, Heritage and Water Branch in EPSDD is working collaboratively with the ACT Data Analytics Centre to implement the ACT Government Data Governance and Management Framework. It is hoped that this will go some way to providing a broader framework for the assessment of aquatic ecosystem health and water quality. It is anticipated this would capture the requirements of a recreational water quality report.<br><br>The Waterwatch annual report card, the Catchment Health Indicator Program (CHIP) report, continues to provide an assessment of the upper Murrumbidgee catchment.<br><br>CMTEDD: The EPA monitors Lake Tuggeranong and Lake Ginninderra for changes to blue-green algae conditions. Samples and subsequence actions taken are in accordance with the ACT Guidelines for Recreational Water Quality. During the swimming season weekly email updates are provided to EPSDD, OCSE, TCCS, NCA, ACT Health, AFP and another 50 stakeholders. Data collected under the EPA program can be used in the provisioning of information to the general public. |
| **29: Establish a government reporting framework for the assessment of aquatic ecosystem health and water quality. This should incorporate work undertaken for the Catchment Health Indicator Program and produce public reports at appropriate intervals to provide meaningful assessments.** | EPSDD: Environment, Heritage and Water Branch in EPSDD is working collaboratively with the ACT Data Analytics Centre to implement the ACT Government Data Governance and Management Framework. It is hoped that this will go some way to providing a broader framework for the assessment of aquatic ecosystem health and water quality. It is anticipated this will capture the requirements of a recreational water quality report.<br><br>The Waterwatch annual report card, the Catchment Health Indicator Program (CHIP) report, continues to provide an assessment of the upper Murrumbidgee catchment. |

| Formal status | OCSE comments in relation to this Investigation |
|---|---|
| Open<br>Source: OCSE Annual Report 2020–21 | This Investigation supports and reinforces the need for this recommendation.<br><br>Coordination of the report prescribed in this recommendation could be managed by the proposed Office of Water. |
| Open<br>Source: OCSE Annual Report 2020–21 | This Investigation supports and reinforces the need for this recommendation.<br><br>Coordination of the report prescribed in this recommendation could be managed by the proposed Office of Water. |
| | |

### Table 2.1 (continued)

| Recommendation | Public government response/evidence |
|---|---|
| **32: Identify opportunities to develop integrated water cycle management (as well as water sensitive urban design) across new and existing urban areas, capturing and using stormwater and creating biodiversity habitat.** | EPSDD: EPSDD is exploring opportunities to develop integrated water cycle management as part of the investigations required under the ACT-led Murray-Darling Basin Water Efficiency Project and through a review of water governance within the ACT.<br><br>Investigations conducted through the ACT Water Efficiency Project included water sensitive urban design, stormwater harvesting and reuse, infrastructure renewal and water demand management. The outcomes of these studies, along with socio-economic modelling, has informed the development of a package of measures that is currently with Government for consideration. Under the Parliamentary and Governing Agreement, the ACT Government committed to 'consider the best administrative arrangements to manage new water programs and provide a holistic and coordinated approach to water programs and policy'. A review has commenced and will report to Government for consideration in early 2022.<br><br>TCCS: TCCS has been working closely with the EPSDD Healthy Waterway project team to provide input and technical advice on the development of opportunities to implement Water Sensitive Urban Design (WSUD) in many locations and to improve codes, standards and the handover process of such assets.<br><br>TCCS currently sits on the cross-directorate Stormwater and WSUD asset steering committee to help improve the design, construction and handover processes for these asset types.<br><br>TCCS has also commenced a WSUD trial at Jamison Centre carpark to assess techniques to improve growth conditions for shade trees in such challenging urban environments. |

| Formal status | OCSE comments in relation to this Investigation |
| --- | --- |
| Open<br>Source: OCSE Annual Report 2020–21 | This Investigation supports and reinforces the need for this recommendation.<br>Coordination of the report prescribed in this recommendation could be managed by the proposed Office of Water.<br><br>Refer also to Auditor-General's Report Recommendation 6 in Table 2.2 and Burley Griffin Recommendation 7 in Table 2.4 below. |

## Auditor-General's Report 1/2018: Acceptance of Stormwater Assets

In its response[13] to the *Auditor-General's Report 1/2018: Acceptance of Stormwater Assets*,[14] the ACT Government summarised the key findings as follows:

- Acceptance processes are particularly deficient with respect to the design of stormwater solutions as these are negotiated between agencies which have competing objectives for stormwater assets.
- The process for developing stormwater solutions would be further enhanced by increased catchment-wide planning and explicit consideration at the design stage of how to fund the maintenance of proposed assets. Options for such funding need to be explored.

**Table 2.2. Summary of progress against Auditor-General Report: Acceptance of Stormwater Assets 2018**

| Recommendation | Public government response/evidence |
|---|---|
| **1. Change to the Estate Development Code**<br>EPSDD should facilitate the amendment of the Estate Development Code to include a gross pollutant target (70–90 per cent removal). | A gross pollutant target of 90 per cent capture is now included in the revised Waterways WSUD General Code. This is the appropriate code for this target. |
| **2. Update of design codes and standards**<br>EPSDD and TCCS, respectively, should facilitate updates to the Waterways Water Sensitive Urban Design Code 2009 and the Design Standards for Stormwater Infrastructure to reflect changes resulting from the 2016 Australian Rainfall and Runoff Guidelines. | Water Sensitive and Urban Design guidelines are complete and have been on public exhibition. The final Territory Plan Variation 354 has been approved by the Minister for Planning and Land Management and tabled at the Legislative Assembly.<br><br>The reference to the 2016 ARR Guidelines was included in the recent update to MIS 08 (2019). |

13. ACT Audit Office, 2018. *Government Response to Auditor General's Report, Acceptance of Stormwater Assets*. ACT Government, Canberra.
14. ACT Audit Office, 2018. *ACT Auditor-General's Report acceptance of Stormwater assets. report no. 1 / 2018*. ACT Government, Canberra.

- There is also an urgent need to review the condition of stormwater assets in established areas of Canberra that will enable an assessment of the Territory's future stormwater needs.
- Governance that supports the acceptance of stormwater assets needs to be improved through improvements in agencies' risk management and performance reporting, and the updating of some codes and standards that guide the design and acceptance of assets.
- The Auditor-General made 17 recommendations which are relevant to this Investigation in 2022.

*Note – The Auditor-General does not have a process for tracking progress towards recommendations beyond information provided by ACT Government directorate in Annual Reports*

| Formal status | OCSE comments in relation to this Investigation |
|---|---|
| Complete<br>Source: EPSDD Annual Report 2020–21[15] | This Investigation supports this recommendation. |
| Complete<br>Source: EPSDD Annual Report 2019–20[16]<br>TCCS MIS 08[17] | This Investigation supports and reinforces the need for this recommendation. |

15. Environment, Planning and Sustainable Development Directorate, 2021. *Annual Report 2020–2021, Environment, Planning and Sustainable Development Directorate*. ACT Government, Canberra.
16. Environment, Planning and Sustainable Development Directorate, 2020. *Annual Report 2019–2020, Environment, Planning and Sustainable Development Directorate*. ACT Government, Canberra.
17. Transport Canberra and City Services, 2021. *Stormwater Municipal Infrastructure Standards 08*. ACT Government, Canberra.

### Table 2.2 (continued)

| Recommendation | Public government response/evidence |
|---|---|
| **3. Alignment of design codes and standards**<br>EPSDD, in consultation with TCCS, should:<br>**a)** align the Waterways Water Sensitive Urban Design Code 2009 with the new Design Standards for Municipal Infrastructure—Stormwater (MIS), and<br>**b)** facilitate the amalgamation of these two documents so traditional drainage and water sensitive urban design are fully integrated. | Water Sensitive and Urban Design guidelines are complete and have been on public exhibition. The final Territory Plan Variation 354 has been approved by the Minister for Planning and Land Management and tabled at the Legislative Assembly.<br><br>It was noted in the ACT Government response to this report that 3. b) was not feasible due to the different purposes of the two documents. |
| **4. Referral entity advice**<br>EPSDD should:<br>**a)** review the potential risks associated with accepting stormwater asset designs, without agency advice, as prescribed under Section 150 of the Planning and Development Act 2007, and<br>**b)** prepare a mitigation strategy to address these risks, and, if legislative changes are required, advise the Minister for Planning and Land Management. | A risk assessment has been undertaken and mitigation strategies have been identified and implemented. Standard conditions are being included in Development Application (DA) Notice of Decisions where no response from TCCS is provided. These are in the form of a condition of approval requiring TCCS endorsement prior to commencement of building works or evidence of TCCS endorsement to be submitted to the authority prior to the approval taking effect (depending on the complexity of the proposal). No legislative changes were identified as part of the mitigation strategy as changes to S150 of the Act could result in implications for meeting statutory timeframes for DA decisions. |

| Formal status | OCSE comments in relation to this Investigation |
| --- | --- |
| Complete<br>Source: EPSDD Annual Report 2019–20 | Although marked as complete, the notes provided by EPSDD for this recommendation do not refer to alignment with the MIS 08. The revised Waterways: WSUD General Code was notified in November 2019, while an updated version of the MIS 08 was published in September 2021. The extent to which these documents are aligned remains unclear. |
| Complete<br>Source: EPSDD Annual Report 2019–20 | The described action appears to mitigate risks to EPSDD. OCSE's interest is in the risk to the environment, which does not appear to have been mitigated. |
| | |

### Table 2.2 (continued)

| Recommendation | Public government response/evidence |
|---|---|
| **5. Catchment-wide stormwater planning**<br>EPSDD should identify options for conducting catchment-wide planning, and undertake analysis of stormwater needs, against which future development applications would be assessed. These options should be provided to the Minister for Planning and Land Management for consideration. | EPSDD: Flood maps are publicly available on ACTmapi, including copies of the relevant flood studies and access to the flood models. The material is available to developers to allow them to design their developments in accordance with the ACT recognised standards. Closed by May 2020 Audit Committee.<br><br>TCCS: Carrying out catchment wide flood modelling of the minor (pits and pipes) and major (overland flow) stormwater network. This is work in progress. Currently, the suburbs of Narrabundah and Duffy have been modelled. |
| **6. Consideration of stormwater solutions**<br>EPSD and TCCS, in consultation with the Suburban Land Agency, should develop a range of stormwater management solutions for new estates and subdivisions, in the context of a catchment-wide plan for the area, to ensure that the optimal solution and the means of financing it are adopted. | EPSDD has revised the Waterways WSUD Code, forming part of the Territory Plan, and previously developed Practice Guidelines for Water Sensitive Urban Design in the ACT. The code provides rules and criteria, and the practice guidelines provide a range of approaches and solutions for meeting the code requirements. These apply to all new developments in the ACT with respect to water use and stormwater management.<br>TCCS has updated the Municipal Infrastructure Standards, including MIS 08 on Stormwater, to better align with code requirements. MIS 08 provides a range of accepted stormwater management measures for use on public land.<br>Ongoing collaboration between TCCS, EPSDD and the SLA will continue towards achieving agreed water use and stormwater solutions for new estates and subdivisions, noting these will be specific to each location and type of development. TCCS has indicated work is ongoing in this area.<br>EPSDD continues to undertake catchment-wide investigations for significant new development areas however these do not capture private infill and redevelopment projects. Further collaboration is required between TCCS, EPSDD and the SLA in achieving agreed stormwater solutions. |

18. Environment, Planning and Sustainable Development Directorate, 2021. *Annual Report 2020–2021, Environment, Planning and Sustainable Development Directorate*. ACT Government, Canberra.

| Formal status | OCSE comments in relation to this Investigation |
|---|---|
| Complete<br>Source: EPSDD Annual Report 2019–20 | Response from EPSDD and TCCS focuses on flood modelling with no mention of water quality, which should be a consideration for catchment-wide planning and stormwater analysis for development application assessments. These are all matters which have been identified in this Investigation as markedly inadequate. It is also not apparent that options have been provided to the Minister for Planning and Land Management. OCSE suggests this recommendation should be re-opened. |
| Complete<br>Source: EPSDD Annual Report 2020–21[18] | The actions cited by EPSDD for the achievement of this recommendation are a duplicate of the actions for recommendation 2. This Investigation has found little evidence of effective stormwater management solutions or a catchment-scale approach for new estates (refer to **Chapter 10**). OCSE suggests that this recommendation should be re-opened.<br><br>Acknowledgement that infill and redevelopment are not currently considered in stormwater planning.<br><br>Refer also to SoE 2019 Recommendation 32 in Table 2.1 above. |
| | |

### Table 2.2 (continued)

| Recommendation | Public government response/evidence |
|---|---|
| **7. Certification of stormwater assets**<br>TCCS should require that certifications of stormwater assets are provided by engineers who are suitably qualified and experienced in stormwater design. | TCCS has indicated that work towards this recommendation is ongoing. |
| **8. Functional review of stormwater management**<br>TCCS in consultation with the EPSD Directorate, should review arrangements for the management of stormwater assets to improve cross-agency management of stormwater. | TCCS has indicated that work towards this recommendation is ongoing. |
| **9. Strategic Asset Management Plan**<br>Roads ACT should, no later than June 2018, update and adopt the Strategic Asset Management Plan, to reflect current stormwater management priorities. | TCCS: The Roads ACT Strategic Asset Management Plan was adopted prior to June 2018 with stormwater management priorities.<br><br>Subsequent updates in 2021 are also planned to include new asset types now included in MIS 08. |
| **10. Development of performance indicators**<br>EPSDD and TCCS should each develop performance measures for the achievement of ACT Government stormwater objectives, including the management of stormwater discharges. These should be publicly reported (for example, in the ACT Water Report). | A qualified erosion and sediment control professional has undertaken a preliminary desk top audit of the impact of the building and construction industry on accepted assets. EPSDD in partnership with EPA (Access Canberra) and the Master Builders Association convened the recommended industry training workshops with targeted professional organisations.[19]<br>TCCS has indicated that work towards this recommendation is ongoing. |

19. Note: in the source material this response is incorrectly recorded against Recommendation 16, with the response to Recommendation 16 recorded against Recommendation 10.

| Formal status | OCSE comments in relation to this Investigation |
|---|---|
| Open | Public reporting on progress against this recommendation would be welcome. This recommendation is in keeping with the findings of this Investigation. |
| Open | Public reporting on progress against this recommendation would be welcome. This recommendation is in keeping with the findings of this Investigation. |
| Closed | Public reporting on progress against this recommendation would be welcome. This recommendation is in keeping with the findings of this Investigation. |
| Complete<br>Source: EPSDD Annual Report 2019–20 | The reported action about industry training does not appear to relate to the recommendation. This Investigation has not found evidence that performance indicators for accepted assets have been developed or implemented by EPSDD or TCCS. OCSE suggests that this recommendation should be re-opened. |
| | |

### Table 2.2 (continued)

| Recommendation | Public government response/evidence |
|---|---|
| **11. Achieving government objectives**<br>TCCS should amend the Requirements for Design Acceptance Submissions procedure to require:<br>**a)** designers to demonstrate how proposed stormwater assets will achieve the objectives of the ACT Government, and<br>**b)** consideration of stormwater objectives when assessing stormwater asset designs. | TCCS has indicated that work towards this recommendation is ongoing. |
| **12. Monitoring the performance of stormwater assets**<br>TCCS should collect stormwater asset performance information, available from various agencies, for use in considering the acceptance of stormwater assets. | TCCS has indicated that work towards this recommendation is ongoing. |

| Formal status | OCSE comments in relation to this Investigation |
|---|---|
| Open | Public reporting on progress against this recommendation would be welcome.<br>This recommendation is in keeping with the findings of this Investigation. |
| Open | Public reporting on progress against this recommendation would be welcome.<br>This recommendation is in keeping with the findings of this Investigation. |
| | |

### Table 2.2 (continued)

| Recommendation | Public government response/evidence |
|---|---|
| **13. Identification of risk**<br>The Development, Review and Coordination Section and Roads ACT and City Presentation business units in the TCCS Directorate should:<br>**a)** undertake a detailed analysis of the risks associated with the acceptance of stormwater assets<br>**b)** include treatments to reduce these risks in their relevant risk registers, and<br>**c)** establish a formal process that communicates these risks to Directorate executives. | TCCS has indicated that work towards this recommendation is ongoing. |
| **14. Improving the accuracy of IAMS[20] data**<br>TCCS should review all IAMS stormwater data to ascertain whether they are accurate and complete. | TCCS has indicated that work towards this recommendation is ongoing. |

20. IAMS is an acronym for Integrated Asset Management System.
21. Transport Canberra and City Services Directorate, 2021. *Annual Report 2020-2021, Transport Canberra and City Services Directorate*. ACT Government, Canberra.

| Formal status | OCSE comments in relation to this Investigation |
|---|---|
| Open | Public reporting on progress against this recommendation would be welcome. This recommendation is in keeping with the findings of this Investigation. |
| Open | Public reporting on progress against this recommendation would be welcome. This recommendation is in keeping with the findings of this Investigation.<br><br>OCSE notes that the 2021 TCCS Annual Report[21] states a new asset management system, the Asset Management Information System (AMIS), is expected to be rolled out this financial year (2021–2022). It states that:<br><br>*The new AMIS will improve consistency and approach to asset management, whilst also improving the feedback loop associated with asset or service related requests or notifications from the public.*<br><br>It is not clear whether this will improve accuracy of stormwater data. |

### Table 2.2 (continued)

| Recommendation | Public government response/evidence |
|---|---|
| **15. Management of the existing stormwater network**<br>TCCS should:<br>**a)** develop a preventative maintenance plan for stormwater assets, and<br>**b)** clearly identify problem areas with, and risks to, the stormwater network.<br>If required, appropriate remedial action should be recommended to the Minister for Transport and City Services. | TCCS: Strategic Asset Management Plan outlines preventative maintenance plan however this plan is currently being reviewed for additional efficiencies and to explore remote sensing technology for asset condition monitoring. |
| **16. Reducing damage to accepted assets**<br>A working group (including representatives from TCCS, EPSDD, the SLA, Access Canberra and other relevant entities) should be established to:<br>**a)** develop a coordinated multi-agency strategy to reduce the damage to accepted assets caused by building and other construction activity, and<br>**b)** report to the Minister for Planning and Land Management on actions to be taken, then subsequently the results of any actions undertaken. | A cross-Directorate working party with representatives from EPSDD, TCCS, SLA and Access Canberra has been established. This working party has been working to address issues raised in the report and provides advice to the Directors-General Water Group. The issues involved are complex and so careful consideration of responses has been required. An action plan is being developed which will inform the responses to recommendations and the timing of actions. It is anticipated that this action plan will be considered by the Directors-General Water Group in late 2019. |

| Formal status | OCSE comments in relation to this Investigation |
|---|---|
| Open | Public reporting on progress against this recommendation would be welcome. This recommendation is in keeping with the findings of this Investigation. |
| In progress | Public reporting the progress of the working group against this recommendation would be welcome. This recommendation is in keeping with the findings of this Investigation. |
| | |

### Table 2.2 (continued)

| Recommendation | Public government response/evidence |
|---|---|
| **17. Review and augmentation of existing stormwater infrastructure** TCCS should develop a forward program for the ongoing review of stormwater infrastructure in established areas of Canberra and augmentation of the infrastructure where necessary. The forward program should be provided to the Minister for Transport and City Services for consideration and direction. | TCCS: Work in progress. TCCS is currently undertaking suburb wide flood modelling to identify flooding hotspots to inform future capital works. |

In their 2018–19 Annual Report,[22] TCCS includes only one response for all the Auditor-General's recommendations (captured above in Table 2.2). No mention of progress against report recommendations is made in any TCCS annual report after this date.

## ACT State of the Environment Report 2015

The SOE Report 2015 made one recommendation which is relevant to this Investigation.

### Table 2.3. Summary of progress against ACT State of the Environment Report 2015

| Recommendation | Public government response/evidence |
|---|---|
| **7. That the ACT Government assess the consequences of, and understand the driving mechanisms behind, the poor condition of water resources as shown by the indicators for total nitrogen, turbidity, chlorophyll-a, and ecological biodiversity, and assess the need for collecting more information for indicators with little available data.** | The Upper Murrumbidgee Waterwatch Catchment Health Indicator Program continued to be supported during 2019–20. The program recorded 2,040 water quality surveys, 184 water bug surveys and 211 riverbank vegetation assessments collected by over 200 volunteers. Collating information provided by various community catchment groups, such as Waterwatch, is critical to the ACT and Region Coordination Group for making informed policy decisions about catchment health.<br>ACT Health participates in the multi-agency Aquatic Monitoring Advisory Group to provide health input into water strategies.<br>TCCS is currently reviewing sampling and monitoring data at select sites and exploring remote sensing technology for asset condition monitoring. |

22. Transport Canberra and City Services Directorate, 2019. Annual Report 2018-2019, Transport Canberra and City Services Directorate. ACT Government, Canberra.

| Formal status | OCSE comments in relation to this Investigation |
|---|---|
| Open | Public reporting on progress against this recommendation would be welcome. This recommendation is in keeping with the findings of this Investigation.<br><br>As noted above, the focus of stormwater infrastructure planning is on water quantity with little evidence of consideration for water quality. |

| Formal status | OCSE Comments in relation to this Investigation |
|---|---|
| Closed | While the Waterwatch program clearly remains an essential component of water quality monitoring in the ACT, this Investigation has found there is still much to be done in terms of understanding the driving mechanisms behind poor quality. Substantial data gaps remain and more funding is required to expand the ACT's water quality monitoring program and provide resources for the data collected to be analysed and used in a meaningful way, including to inform management actions. |

## Report on the State of the Watercourses and Catchments for Lake Burley Griffin

The ACT Commissioner for the Environment and Sustainability's Report on the State of the Watercourses and Catchments for Lake Burley Griffin made 14 recommendations which are relevant to this Investigation.

### Table 2.4. Summary of progress against the Report on the State of the Watercourses and Catchments for Lake Burley Griffin

| Recommendation | Public government response/evidence |
|---|---|
| **1. The ACT Government (Health Directorate) undertake periodic reviews of the ACT Guidelines for Recreational Water Quality at intervals of not less than five years and include consultation with relevant stakeholders.**<br>The reviews should consider:<br>**a)** developments in use of enterococci bacteria as an indicator of faecal contamination and research on the health risks associated with regrowth pathogens<br>**b)** improvements in knowledge and technologies to determine whether toxin testing or blue-green algal concentration and algal biovolume testing is most relevant for ACT lakes, and<br>**c)** the characteristics and regrowth challenges of the lake embayments. | The guidelines were last updated in 2014.[23] |
| **2. The current guidelines should be amended to recognise:**<br>**a)** the potential for lake or part-lake closure on a case by case basis, based on unusually extreme levels of blue-green algae, and<br>**b)** closure practices in relation to very high bacteria concentrations. | The guidelines were last updated in 2014. They allow for the CHO to advise closure of a water body or part of a water body. |

23. Health Directorate, Health Protection Service, 2014. *ACT Guidelines for Recreational Water Quality*. ACT Government, Canberra.

| Formal status | OCSE comments in relation to this Investigation |
|---|---|
| Closed<br>Source: OCSE | Review of the guidelines every five years as per this recommendation does not seem to have been taken up. This recommendation remains relevant in 2022. |
| Closed<br>Source: OCSE | This Investigation supports and reinforces the need for this recommendation. |

### Table 2.4 (continued)

| Recommendation | Public government response/evidence |
| --- | --- |
| 3. In line with the current Guidelines, the ACT Government and the Queanbeyan City Council, should identify and map sources of faecal contamination entering urban stormwater systems, the significance of the sources, and long-term strategies for reducing loading. In addition, a rigorous report on the state of watercourses and catchments for Lake Burley Griffin and comprehensive procedure for rapid 'sanitary surveys' in the event of elevated indicator concentrations should be established. | Currently ACT Health undertakes surveys to identify sources of contamination in response to contamination being identified in waterways. The sanitary inspection guides actions required to be undertaken where sources of contamination are identified in recreational water bodies. The survey involves defining the catchment areas and physical characteristics, public use of the recreational site, possible sources of faecal/sewage pollution, stormwater discharge points, pollution from animals (domestic, farm or wild) and management controls regarding microbiological risks. |
| 4. The ACT Government and the National Capital Authority improve communication with Lake user groups and the general public in the following key areas:<br>**a)** during prolonged Lake closures, so that Lake users are aware that the Lake is closed and why<br>**b)** during closures or restrictions, Lake managers should undertake random checks on Lake use, and where necessary amend public notification methods to ensure lake users are aware of the alerts and management responses, and<br>**c)** when the Lake is reopened. | Processes are in place. |

| Formal status | OCSE comments in relation to this Investigation |
|---|---|
| Closed Source: OCSE Annual Report 2016–17 | Like most monitoring in the ACT, this action describes reactive rather than proactive monitoring.<br>This Investigation has not found evidence of strategic mapping of faecal contamination sources. This recommendation remains relevant in 2022. |
| Closed<br>Source: OCSE Annual Report 2013–14 | This Investigation supports and reinforces the need for this recommendation. |
| | |

## Table 2.4 (continued)

| Recommendation | Public government response/evidence |
|---|---|
| 5. The National Capital Authority and the ACT Government undertake a feasibility study, including a triple bottom line analysis, of macrophyte restoration across the Lake. Priorities for consideration should include:<br>**a)** construction of a wetland in the Lake between Springbank Island and the mouth of Sullivans Creek<br>**b)** construction of a wetland in the Lake at East Basin, and<br>**c)** restoration of macrophyte beds in Lotus Bay, Orana Bay, and at Weston Park East Beach. | None of these projects were deemed feasible. |
| 6. The National Capital Authority and the ACT Government jointly explore initiatives for in-lake interventions aiming to control blue-green algae in Lake Burley Griffin and other Canberra lakes. Desktop research, physical trials and cost-benefit analyses could examine (but not be limited to) systems for:<br>**a)** re-aerating sediments<br>**b)** stirring the water column<br>**c)** adsorbing and removing phosphorus from the water via additions of clay- or chemical-based substances, and/or<br>**d)** treating lake sediments to reduce phosphorus release, including by addition of nitrates or iron chloride to the water. | Trials of in-lake interventions began in Lake Tuggeranong in 2017–18 and are ongoing.[24] OCSE is not aware of in-lake intervention trials in other urban lakes. |

24. ACT Healthy Waterways, 2021. *Lake Tuggeranong research trial*. ACT Government, Canberra.

| Formal status | OCSE comments in relation to this Investigation |
| --- | --- |
| Closed<br>Source: OCSE Annual Report 2016–17 | Public reporting on the detail of these feasibility studies would be welcomed. |
| Closed<br>Source: OCSE | The results from the Lake Tuggeranong trials may yield results that can inform management of other lakes, although each lake environment is different and may not respond to interventions in the same way. |
| | |

### Table 2.4 (continued)

| Recommendation | Public government response/evidence |
|---|---|
| 7. The ACT Government should develop a strategic approach to WSUD. This should include:<br>**a)** Identifying sites where installing catchment intervention, such as wetlands and pollution control ponds, would improve water quality entering Lake Burley Griffin. This should include:<br>**i.** initial feasibility studies into the construction of pollution control ponds or wetlands on the Yarralumla drainage line and Jerrabomberra Creek. Any installations should be designed to be of an appropriate size to treat the catchment area they service.<br>**ii.** identifying WSUD that complement current programs of installing wetlands and water control ponds in both new urban areas and retrofitting in existing suburbs where applicable.<br>**b)** Ensuring that WSUD requirements are enforced in particular:<br>**i.** ensuring that wetlands and ponds are of appropriate sizes to service their catchments, and<br>**ii.** undertaking auditing/compliance arrangements to ensure that temporary pollution control ponds for sediment control during the construction phase in new estates are maintained and functioning effectively.<br>**c)** Monitoring the effectiveness of WSUD through improved monitoring following urban developments to determine whether water quality meets WSUD general code targets. Results should be used to inform improvements in WSUD standards.<br>**d)** Comparison of ACT approaches to WSUD with those of other Australian urban areas to help ours remain consistent with developing technology and best practice. | The Healthy Waterways Project has satisfied much of 7. a). Relevant ACT Government directorates have reported annually to OCSE on this recommendation and this remains ongoing.<br>TCCS: ACT Healthy Waterways project – maintenance of existing assets ongoing and construction of new assets are planned. TCCS are currently undertaking a comprehensive audit and reporting on the condition and efficacy of existing GPTs and by May 2022 the audit will be complete, work is already underway from the findings of the audit. |

| Formal status | OCSE comments in relation to this Investigation |
|---|---|
| Open<br>source: OCSE Annual report 2019–20 | The lack of a strategic approach to WSUD and urban catchment management is a key finding of this Investigation. While the Healthy Waterways Project has greatly enhanced public realm WSUD capacity in Canberra, other elements of this recommendation relating to enforcement and compliance, and monitoring and effectiveness, are still major issues for water management in the ACT. This recommendation remains highly relevant in 2022.<br><br>Also refer to State of the Environment 2019 Recommendation 32 in Table 2.1 and Auditor-General's Recommendation 6 in Table 2.2. |

### Table 2.4 (continued)

| Recommendation | Public government response/evidence |
|---|---|
| **e)** Reviewing the efficacy of existing GPTs. The review should include:<br>**i.** effectiveness in pollutant reduction<br>**ii.** effectiveness of current maintenance of pollution control measures<br>**iii.** capital costs<br>**iv.** ongoing maintenance costs to ensure the current drainage infrastructure remains high-standard and is in line with current best practice, protecting downstream environments<br>**v.** reduction of polluted leachate water, and<br>**vi.** the capacity to manage requirements of future urban growth and development.<br>**f)** working with the NCA and NSW councils in the catchment to coordinate a strategic approach across the catchment. | |
| 8. The ACT Government, Queanbeyan City Council and National Capital Authority work collectively to raise awareness of the impact of organic matter, and other household or commercial materials (e.g., garden and lawn fertilisers) on the Lake Burley Griffin catchment. Information should include the contribution that all sectors of the community can make to improving water quality by appropriately using and disposing of such materials. | The H2OK Program fulfils many of these functions, and is cross-jurisdictional. The ACT and Region Catchment Management Coordination Group has also played a role in meeting this recommendation. |
| 9. The ACT Government and Queanbeyan City Council evaluate their street sweeping practices and schedules to minimise leaf litter and other organic matter from having adverse impacts on Lake Burley Griffin's water quality. | TCCS is part-way through a project to optimise its street sweeping practices, developing and implementing a new approach which will allow it to collect much more leaf litter with current resources. |

25. ACT Healthy Waterways, 2021. *H2OK - Keeping our waterways healthy*. ACT Government, Canberra.

| Formal status | OCSE comments in relation to this Investigation |
| --- | --- |
| Closed<br>Source: OCSE | This Investigation supports and reinforces the need for this recommendation. |
| Closed<br>Source: OCSE | Queanbeyan City Council is outside the scope of this report. |
| | |

**Table 2.4 (continued)**

| Recommendation | Public government response/evidence |
| --- | --- |
| 13. The ACT Environment Protection Authority (EPA) review and update the Environmental Authorisation number 0417 for sewage treatment within the Queanbeyan City Council Sewage Treatment Plant (QCCSTP) to ensure that the treatment process results in discharge quality that matches contemporary best practice for a modern, urban sewerage treatment plant. In line with this, the QCCSTP should continually review and improve its mitigating practises for inundation and washout events at the treatment plant. | The Environmental Authorisation for QCCSTP was revised in December 2017 to make the conditions clearer and more enforceable, introduce a requirement for an environment management, and provide clarification on bypass events. Sampling requirements were updated to allow for modern online analysers to be used for reporting the concentration of some effluent parameters. Changes to discharge quality requirements were not included in this revision. |
| 14. The ACT Government require ACTEW to report regularly on the condition of the sewer system in urban areas in the Lake Burley Griffin catchment and identify priorities for upgrading to reduce sewer blockages and possible leakages from the system, and reduce the risk of system failures. | |
| 16. A comprehensive assessment of the environmental, social and economic value of key lakes in the ACT be undertaken and take into account current and predicted challenges to water quality. This assessment should inform:<br>**a)** a review and update of Canberra's Urban Lakes and Ponds Plan of Management involving extensive community consultation and taking into account the long-term challenges to water quality in the urban catchments<br>**b)** the need for government investments in water quality<br>**c)** decisions regarding trials of appropriate in-lake and catchment management measures, with the results assessed from scientific (environmental), social and economic perspectives, and<br>**d)** decisions regarding implementation of lake and catchment management options. | An updated version of the Urban Lakes and Ponds Plan of Management was released in 2022. TCCS Better Suburbs project in 2018 found that the Canberra community considers urban lakes, ponds and waterways more important than any other municipal asset or service. |

| Formal status | OCSE comments in relation to this Investigation |
|---|---|
| Closed<br>Source: OCSE | This recommendation remains highly relevant. |
| Closed<br>Source: OCSE | This Investigation has not found sewer leaks to be reported as a significant contributor to poor water quality in urban lakes. |
| Closed<br>Source: OCSE | While elements of this recommendation have been completed, modelling of water quality outcomes under different management regimes is not evident. A comprehensive values assessment of urban lakes has also not been undertaken. This recommendation remains relevant in 2022. |

**Table 2.4 (continued)**

| Recommendation | Public government response/evidence |
|---|---|
| 17. The ACT, Australian, NSW and local governments establish a Burley Griffin Molonglo-Queanbeyan catchment management agreement. Such an agreement should outline:<br>**a)** strategic objectives for the integrated and coordinated management of the Lake and catchments, to encompasses water quality, environmental flows, potable water, land use, wastewater, and future urban and climate change impacts on the catchment<br>**b)** each party's responsibilities for water quality in the Lake and its catchments<br>**c)** a long-term catchment planning framework, and<br>**d)** an evidence-based, adaptive, management workplan.<br>To avoid past challenges of multi-jurisdictional catchment management coordination, such an agreement should include a dedicated governance group with representation from all jurisdictions, a consistent and persistent mechanism to ensure implementation and accountability, and reporting requirements.<br>The National Capital Authority, as Lake manager, should in the first instance convene a meeting of relevant jurisdictional representatives to guide the above recommendations. | The ACT and Region Catchment Coordination group was established as a statutory body under the Water Resources Act 2007, following an amendment to that Act. |

| Formal status | OCSE comments in relation to this Investigation |
|---|---|
| Closed<br>Source: OCSE | This Investigation supports and reinforces the need for this recommendation. |

| Formal status | |
|---|---|

# 3

# Ngunnawal cultural water[26]

*Molonglo Gorge. Source: Miranda Gardner*

Contents

## 3.1. Traditional Ecological Knowledge

Recognition of the cultural value held by the Ngunnawal people of Canberra's urban waterways is critical for their effective management. Creeks and rivers provide an essential link to connect back to Country. Despite the modification of Canberra's urban waterways, these waters remain culturally significant today and are associated with pathways, Songlines and important ceremonial areas and living places. This includes the Molonglo River, creeks such as Sullivans and Ginninderra, and many other water environments. It is also important to recognise that the construction and modification of Canberra's lakes and waterways have resulted in the loss, or significant alteration to, many culturally significant sites. Traditional Ecological Knowledge incorporates thousands of generations of wisdom and experience. As such, this Knowledge has already assisted adaptation to changing climates and environments over the years. In our dry country, the management of water into the future is particularly vital. Traditional Knowledge can provide critical insights into how to increase resilience in the face of climate change.

> *'Aboriginal people have adapted and mitigated and evolved to the driest inhabited continent on Earth, and without that evolution, they would have died out thousands of years ago,' stated Bradley Moggridge, hydrologist and Associate Professor of Indigenous water science at the University of Canberra.*[27]

The value of Traditional Ngunnawal water knowledge needs to be recognised and incorporated into the contemporary management of Canberra's urban waterways to improve aquatic health. The opportunity to restore Canberra's now heavily urbanised and modified waterways in partnership with the Ngunnawal Community, as well as the application of Traditional Ngunnawal Knowledge, should be seen as priorities for waterway management in the ACT (see section **10.2 Incorporating Ngunnawal Knowledge into water policy and management**.)

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26. Throughout this Investigation, the terms Indigenous, Aboriginal or Traditional Knowledge, have been retained where provided by contributors or referring to specific named positions or published documents. OCSE understands that term First Nations is the current preference for referring to Australia's Aboriginal and Torres Strait Islander cultures and identities.
27. Palmer, J., 2021. *Water Wisdom: The Indigenous scientists walking in two worlds*. https://doi.org/10.1029/2021EO210597. Eos, Science News by AGU, published on 22 November 2021.

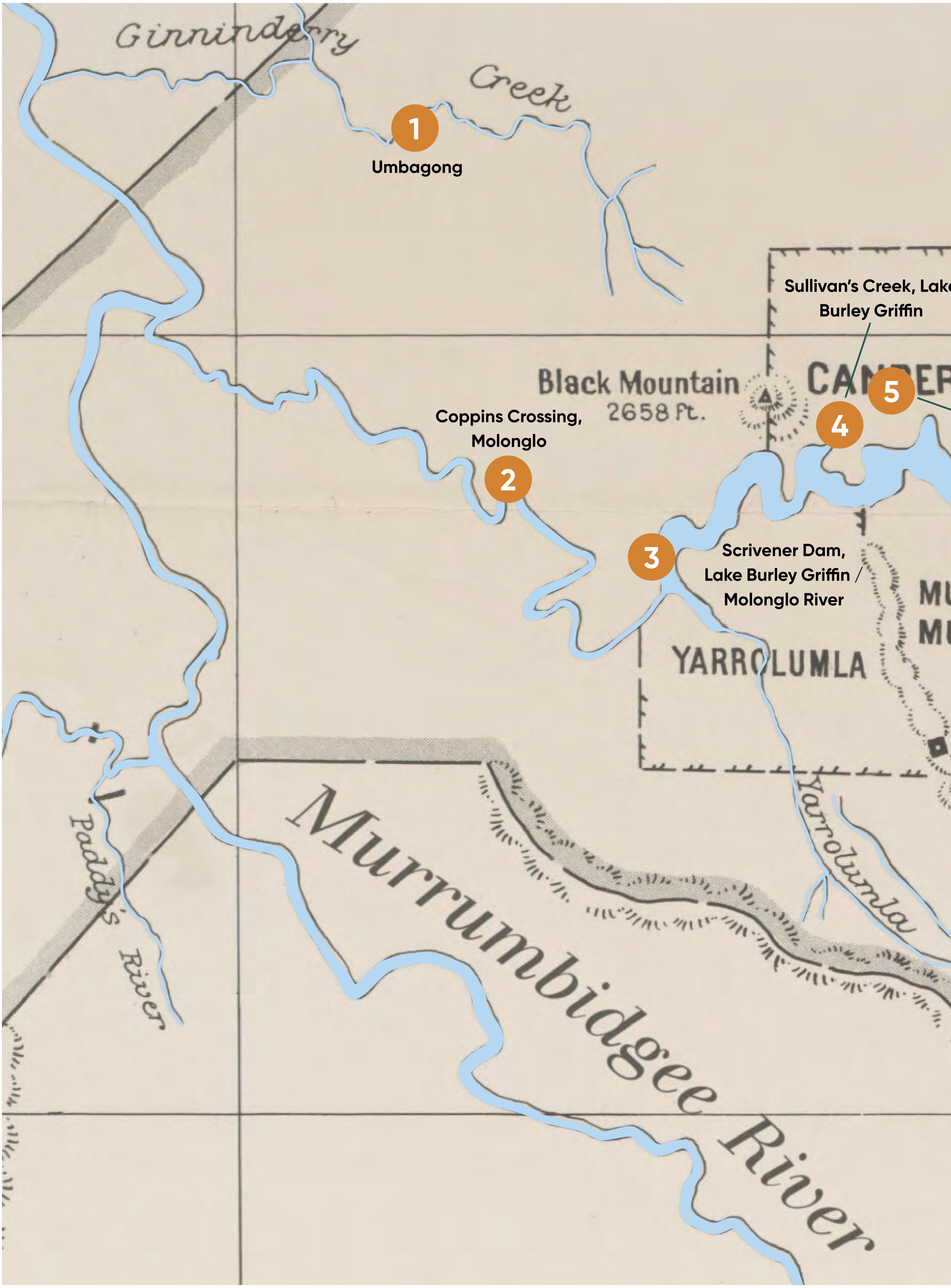
## 3.2. Ngunnawal connection to waterways

The Ngunnawal people maintained strong cultural connections to the waterways of the region, before major changes were made with the development of Canberra. The following infographic highlights the location of seven cultural sites which are now within, or close to, urban areas of Canberra. These sites are significant as places which were previously used by the community for activities including ceremony, celebration, fishing, hunting and the creation of artefacts. This is detailed in the ACT Water Resource Plan.[28]

The Australian National University has also published an Aboriginal Heritage Trail[29] which provides details of the cultural significance of this area surrounding Sullivans Creek, the way in which Aboriginal people have used this area for thousands of years and their continuing culture and connection to Country.

*Painting of Ginninderry New South Wales by Robert Hoddle, 1832. Source: the National Library of Australia.*

28. ACT Government, 2019. *ACT Water Resource Plans for Surface Water and Groundwater*, ACT_water_resource_plan_part_1_Pt14_Redacted.pdf (mdba.gov.au).
29. Australian National University, *Aboriginal and Torres Strait Islander Heritage Trail*. https://services.anu.edu.au/files/guidance/Aboriginal_Heritage_Trail2.pdf


Ginninderry
Creek
1
Umbagong
Sullivan's Creek, Lake
Burley Griffin
Black Mountain
2658 Ft.
CAN
5
4
Coppins Crossing,
Molonglo
2
3
Scrivener Dam,
Lake Burley Griffin /
Molonglo River
YARROLUMLA
Murrumbidgee River
Paddy's River
Yarrolumla


*Proposed Federal Territory Canberra with detail connected with water supply.*
**Map derived from:** New South Wales Department of Lands & C. R. Scrivener (1909).

## Burning for long-distance flyers

Collaboration between government agencies and First Nations peoples for fire and land management in southern Australia has, until recently, been scattered. While successful case studies existed, very little academic research had been undertaken.

Following the 2019–20 bushfires, the media highlighted some tangible examples of where cultural burns had protected property during this awful summer.[30] Since then, the incorporation of First Nations practices in fire management is being increasingly pursued and academic research is also exploring this.

There are a range of benefits of First Nations fire and land management, including cultural, environmental, economic and social (health and wellbeing). However, a range of barriers also exist which need to be considered if these practices are to become more widespread.[31] These include the challenge of burning in areas with high populations, complex rural and peri-urban interfaces, the effectiveness of Traditional burning practices in landscapes significantly altered with introduced plants and animals, climate change and the strict regulations around fire management today.[32]

Jerrabomberra Wetlands are an important fertile freshwater area located upstream of Lake Burley Griffin in the ACT. At this location in September 2015, Ngunnawal man Uncle Carl Brown lit what is understood to be the first cultural burn in the ACT Parks and Conservation Service cultural burning program.[33] In doing so, he returned his ancestors' practices to the wetlands. The slow cool burn took out dead organic matter in the vegetation, making it easier for small reptiles, animals and birds to navigate their particular nesting areas. It is vital to recognise that in the ACT, cultural burning must involve Ngunnawal and Ngambri leadership and involvement as the Traditional Custodians of this landscape, otherwise it loses its meaning.[34]

Since 2015, the Murrumbung Rangers, led by ACT Parks Fire Officer Dean Freeman, a Wiradjuri man, have regularly burnt parts of Jerrabomberra Wetlands to help control weeds and remove rank grass and other vegetation. The burnt ground adjacent to the edge of the water has been frequently used by the Latham's Snipe (Gallinago hardwickii), a bird which migrates to Australia in spring from its breeding grounds in Japan and Russia. It breeds during the

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30. McKemey, M., Neale, T., and Costello, O., 2021. *Principles for Enhanced Collaboration Between Land and Emergency Management Agencies and Indigenous Peoples*. Bushfire and Natural Hazards CRC.
31. Ibid.
32. Freeman, D., Williamson, B., and Weir, J., 2021. *Cultural burning and public sector practice in the Australian Capital Territory*. Australian Geographer, 52(2), 111-129.
33. Ibid.
34. Ibid.

northern hemisphere summer and returns to Australia to spend its non-breeding time feeding in preparation for its return flight. This is a trip of around 9000 kilometres one way. The birds can travel all the way to Tasmania but 20–30 settle at Canberra's own Jerrabomberra Wetlands each year.[35] They stay until late January/early February when they return to the northern hemisphere.

*Prescribed burning by the Murrumbung Rangers at Jerrabomberra Wetlands.*
*Source: Michael Maconachie.*

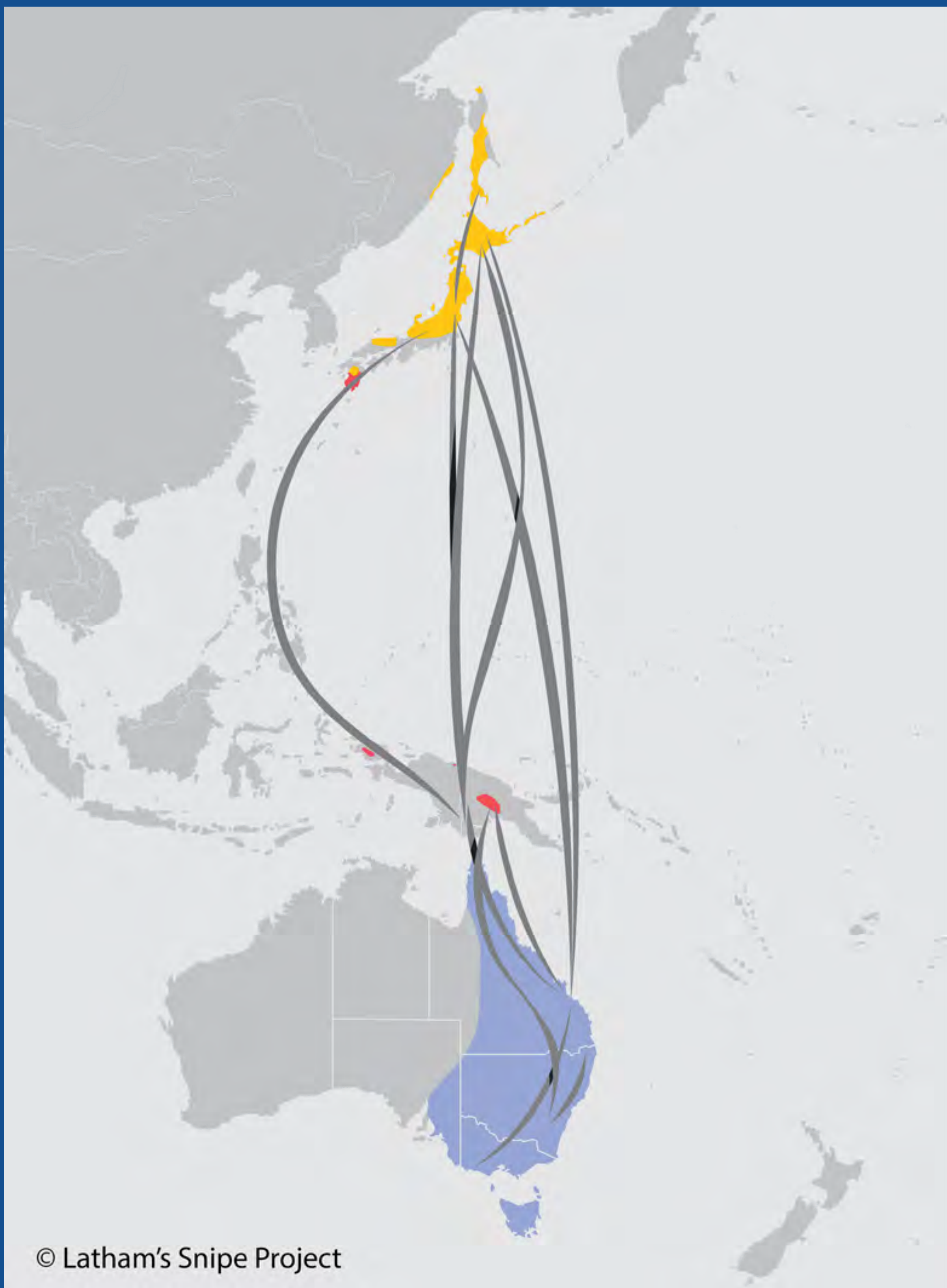
The cultural burning of the Jerrabomberra Wetlands is ecologically vital as it improves the habitat suitability of the area to enable these tagged birds to capitalise on the food resources and to successfully migrate these amazing distances.

35. Travers, P., 2016. Tracking Latham's snipe migration from Japan to southern Australia. ABC News, published on 12 May 2016.

The Latham's Snipe is one of three Gallinago species that occur in Australia but it is the only one that is distributed throughout all of eastern Australia. It is a very shy bird and if disturbed from its hiding spot, will burst out in fast flight with a loud 'crek' call, before finding a new place to hide.[36] Birds have been previously captured at Jerrabomberra Wetlands and fitted with devices to obtain movement and migration information. This information will assist in determining their migration routes between Australia and the northern hemisphere. This helps identify important stopover sites for the birds on their migration so we know which wetlands to protect.

*A Latham's Snipe with the tag and transmitter. Source: Heather McGinness.*

36. Birdlife Australia, Latham's Snipe, Latham's Snipe | BirdLife Australia.




*Global distribution map for Latham's Snipe showing the breeding range (yellow), non-breeding range (blue) and migration stopover regions (red). Lines indicate known migration routes between the breeding and non-breeding ranges. The westerly route through the Philippines is hypothesised but evidence to support it has yet to be obtained. Source: The Latham's Snipe Project.*

## We should want to sunbathe in stormwater channels

*Kate Harriden*

Concrete stormwater channels are a common sight in Canberra's suburbs. Kate Harriden, a Wiradyuri woman and PhD scholar at the Fenner School of Environment and Society (Australian National University), thinks we should want to sunbathe in them. First, she says, channels need to be attractive, so people want to spend time there. Canberrans travel to sunbathe along riverbanks in the Murrumbidgee corridor. If the creeks of Canberra, tributaries in the Murrumbidgee catchment, were not stormwater channels, people might want to sunbathe closer to home.

Even though people know stormwater channels are not as healthy as creeks, they are still drawn to them, 'people love them because of the water,' Kate says. 'They want to be able to sit. They want to be able to hear a bird sing. They want to hear a frog croak. They want the dog to be able to go for a swim.'[37]

Kate's research is about improving water quality in stormwater channels using Indigenous sciences, water management tools and techniques. To test her theories, Kate has been installing small infrastructure made from natural materials in the drain that is Yarralumla Creek, between the Curtin rain gardens and north Curtin horse paddocks. This infrastructure, leaky weirs and channel bank storage sites, is built as a treatment train. Treatment trains are when infrastructure is designed to work together to improve water quality. The channel bank storage sites, once they contain enough organic matter or vegetation, provide treatment avenues for water collected during high flows. Water from the channel bank storage sites filters out to the leaky weirs, which in turn slow the water flow. The slower flow forces sediment out of the water column, creating islands. Water travelling though these islands can experience water quality changes.

'We can't keep having stormwater channels function the way they do,' she says. 'They just flush dirty water out to some other place. It's all wasted water and you can't recycle the nutrients; you're just moving a pollutant from one area and over-polluting another.'[38]

37. Carvan, T. *This story will change how you feel about drains*. Australian National University News. https://science.anu.edu.au/news-events/news/story-will-change-how-you-feel-about-drains
38. Ibid

*Looking upstream to the leaky weirs. Source: Kate Harriden.*

While the main activity of the research is to monitor the impact of this infrastructure on water quality, an outcome of the treatment trains is attracting peoples and animals to waterways, making the concrete drains more appealing. Kate emphasises Indigenous perspectives centring on the interconnectedness of water cycles and systems with Country. Reintegrating natural systems into waterways and reducing reliance on concrete will help centre Country in urban water management while re-establishing Indigenous relationships with water.[39]

39. Harriden, K., 2021. R*eimagining our urban waterways: Environment Exchange,* organised by the Conservation Council, ACT Region.

‘Indigenous people will spend more time at a site, looking at how the site functions,’ she explains. ‘We’re not looking at just, how does this work for me? It’s like, how does this work for the animals and the plants? And what does the water want to do? How does the sun affect that? How are all of these things influenced by the water and how do they influence the water?’[40] Considering these types of questions, where it is not all about human wants and needs, reflects relational accountability. Being accountable to Country and more than just human needs is a fundamental Indigenous way of being, valuing, knowing and doing.

Kate explains that an essential component of this project is spending time in the stormwater drains, deeply observing conditions. She says, ‘if you want to maintain both environmental and social resilience, you actually need those spaces where kids can go and scare the poor, old water dragons.’ For adult humans, the opportunity to sunbathe along urban streams in places such as vegetated channel bank storage sites represents opportunities for environmental and social resilience. The reintroduction of the water exchange processes, extinguished when the original channel bank storage sites were covered in concrete, builds environmental resilience. Being able to sunbathe close to home enhances social resilience. Deeper connections with urban waterways helps people to connect to, and value, their local environment.

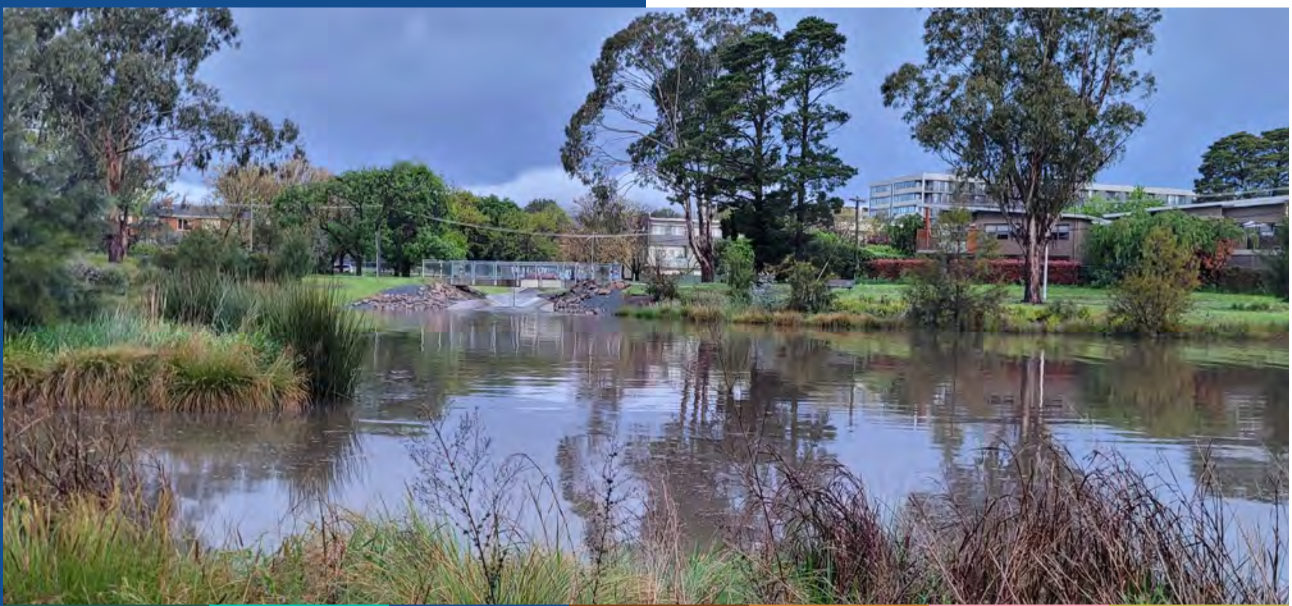
‘We can’t help ourselves. People just like watching water,’ Kate says. To watch water while sunbathing on a vegetated channel bank storage site close to home is something some of us want, and should be able to do.

40. Carvan, T. *This story will change how you feel about drains*. Australian National University News. https://science.anu.edu.au/news-events/news/story-will-change-how-you-feel-about-drains

*Modification by Kate to test theories about slowing water movement in stormwater channel. Source: Kate Harriden.*

# 4

# Contemporary values and expectations of urban lakes and waterways



*Lyneham Pond. Source: Fiona Dyer*

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The ACT's lakes and waterways are highly valued and now serve multiple purposes. Values confer a set of expectations around urban waterways in terms of the way they function, the types of ecosystems they support and their water quality. Foremost, as discussed in **Chapter 3 Ngunnawal Cultural Water**, there are deep and enduring Ngunnawal cultural values held by the ACT's lakes and waterways. Stormwater management, amenity, recreation and ecosystem services are the main non-Indigenous 'values' perceived to be held by urban waterways of the ACT.

## 4.1 Why do we have urban water management?

The constructed lakes and modified waters in Canberra have two main water management purposes:

1. To minimise flood risk: concrete-lined creek channels are constructed to transport stormwater away from urban and commercial areas during heavy rainfall events. Constructed urban lakes, ponds and wetlands also serve to attenuate flood peaks and reduce flooding risk such as ponds in Dickson, Lyneham, East O'Malley and Flemington Road. Urban water management is largely focused on minimising flood risks to people and property damage.

2. To manage water quality: urban lakes, ponds and wetlands are also constructed to protect the environmental health of downstream waterways by intercepting and removing the pollutants associated with urban areas such as nitrogen, phosphorous and suspended sediments. This function is the most important environmental objective of Canberra's constructed waterways, especially for minimising the impacts of the urban environment on the Murrumbidgee River and Lower Molonglo River, as well as the Murray-Darling Basin.

The constructed urban lakes, ponds, streams and wetlands in the ACT were designed and built predominantly to deliver these stormwater management outcomes. The hierarchy of objectives, as listed in the Canberra Urban Lakes and Ponds: Land Management Plan notes that flood control is the first objective.

However, stormwater and water quality management are not the only important functions Canberra's urban lakes and waterways provide. Canberra's variety of waters deliver many other benefits including ecosystem services, biodiversity, climate regulation and water resources for non-potable uses such as irrigation for playing fields and gardens. As Australia's largest inland city, the value and importance of Canberra's urban waters are considerable, significantly contributing to the liveability of the city. Urban lakes and waterways provide a focal point for the community, a site of recreation (such a swimming, boating and fishing) and are an integral part of the design and character of the national capital.

## 4.2 Community values of urban lakes and waterways

There is a large body of research that demonstrates constructed waterways can become highly valued by the community, are increasingly being recognised as providing a range of positive outcomes and for playing a central role in shaping sustainable cities.[41] If well-maintained, urban waterways, and the land around them, provide opportunities for recreation, environmental education and enhancing social wellbeing.[42,43,44] These values will differ for each individual or group, depending on their interest, knowledge and interactions with urban waterways.

Canberra's lakes and waterways, and the green spaces that surround them, are a focal point for community activities and events across the city.

The value ascribed to urban waterscapes by the Canberra public was clearly demonstrated in 2018, when the ACT Government ran a deliberative democracy process entitled Better Suburbs. This was conducted by the Transport Canberra and City Services Directorate to find out what a cross-section of Canberrans believed were the areas that the ACT Government should be focussing on most urgently. This forum identified 'Lakes, Ponds and Wetlands/Stormwater and Water Quality' as the most important of 14 issues.

Whilst these values are particularly relevant to the iconic Lake Burley Griffin, both Lake Tuggeranong and Lake Ginninderra were designed as the central aesthetic and recreational place for their respective communities. Even small ponds and wetlands provide sites for a range of activities within the community and potential positive community outcomes such as opportunities for social interaction, recreation, community engagement with volunteering, education, visual amenity, and enhancing social wellbeing.

*Boat on Lake Burley Griffin. Source: Wikimedia Commons*

41. Haase, D., 2015. *Reflections about blue ecosystem services in cities*. Sustainability of Water Quality and Ecology, 5, 77-83.
42. Hunter, R. F., et al., 2019. *Environmental, health, wellbeing, social and equity effects of urban green space interventions: A meta-narrative evidence synthesis*. Environment international, 130, 104923.
43. Foley, R., and Kistemann, T., 2015. *Blue space geographies: Enabling health in place*. Health & place, 35, 157-165.
44. Haeffner, M., et al., 2017. *Accessing blue spaces: Social and geographic factors structuring familiarity with, use of, and appreciation of urban waterways*. Landscape and Urban Planning, 167, 136-146.

## The Canberra community and waterways[45]

The importance of lakes and waterways to the Canberra community is shown in the results of a 2016 survey conducted by the University of Canberra. Eighty per cent of survey respondents reported spending time at one or more waterway located in the ACT, particularly at Lake Burley Griffin (77%), Lake Ginninderra (41%) and Lake Tuggeranong (31%).

The most common activities undertaken on visits were walking/jogging around ACT's large lakes, urban ponds and constructed urban wetlands. Picnics and barbeques were also common around the lakes, as was cycling. Boating was most common on Lake Burley Griffin. However, swimming was most common in the Murrumbidgee/Cotter River area, rather than urban lakes. This indicates that primary contact water activities such as swimming are not undertaken as much as non-water contact activities at urban lakes and waterways.

The survey noted many benefits for community members in spending time around lakes and waterways, including higher levels of health and wellbeing, an increased uptake of actions to protect water quality, and an increase in water quality of local waterways.

**Perceptions of water quality**

Poor water quality is clearly an issue for Canberrans with water quality in lakes perceived to be a problem by 59 per cent of survey respondents, including for Lake Tuggeranong (63%) and Lake Burley Griffin (58%). For comparison, 36 per cent felt poor water quality in natural rivers, streams or creeks was a problem, and 33 per cent that poor water quality in local wetlands was a problem. For almost all waters, a quarter or more of users indicated they did not know enough to rate how good or poor the water quality was, highlighting a lack of awareness and knowledge of water quality in local waterways even by those who spend time around them.

The survey also identified that the community broadly had different perceptions to scientists about the causes of water quality problems. For the community, most considered litter a big problem for local water quality (62%), followed by blue-green algal blooms (60%) and pest fish species (59%). In contrast, water scientists considered the highest priority problems to be organic matter in the form of leaves and grass clippings entering waterways, littering (e.g., rubbish not disposed of responsibly), erosion of stream banks, blue-green algal blooms (lakes only), erosion from construction and other worksites, and high bacteria levels. Perhaps the biggest difference between residents and experts related to leaf litter and grass clippings entering the stormwater system. This issue was considered a major contributor to water quality issues by water scientists but was considered a problem by only 38 per cent of survey respondents.

45. Information and data sourced from: Schirmer, J., and Mylek, M., 2016. *Water quality and the community: understanding the views, values and actions of residents of the ACT and surrounding region*. University of Canberra, Canberra.

## 4.3 Environmental values of urban lakes and waterways

Maintaining good water quality and aquatic ecosystem health in urban areas has many environmental benefits,[46,47,48,49] including:

- protection of biodiversity, including migratory birds
- creation of valuable habitats for biodiversity, both terrestrial and aquatic, including fish, birds, frogs, turtles, yabbies and insects
- refuges for wildlife in times of drought
- macrophyte establishment and protection of riparian vegetation which prevent erosion, intercept and capture pollutants, and provide a buffer zone between the urban areas and the waterways, and
- establishment and maintenance of native plants which are critical to Canberra's green infrastructure.

The potential value of constructed lakes and waterways is well demonstrated by Jerrabomberra Wetlands. This wetland was created when Lake Burley Griffin was constructed and is now nationally important as a significant site for biodiversity, including over 170 different bird species. In addition, the area around Yerrabi Pond has become habitat to the endangered superb parrot.

## 4.4 Economic and health considerations

Whilst considerations of the economic impacts of poor water quality and ecosystem health are outside the scope of this Investigation, the 2012 OCSE report on the state of Lake Burley Griffin estimated the annual economic cost of poor water quality in Lake Burley Griffin alone to be $25.5 million.[50] This was based on a continued deterioration in the quality and reliability of the Lake as a sports venue, and included not only the loss in economic value accruing to Canberra as a result of cancellation of lake related activities, but also the additional costs incurred by organisations in terms of devaluation of equipment and facilities, and costs incurred in travelling to venues outside of the ACT.

The current figure for economic losses caused by poor water quality would now be significantly higher given the $25.5 million estimate was undertaken 10 years ago, and does not include other Canberra lakes and waterways. This demonstrates that healthy urban waters have value beyond that of environmental management.

46. Kandulu, J. M., Connor, J. D., and MacDonald, D. H., 2014. *Ecosystem services in urban water investment*, Journal of environmental management, 145, 43-53.
47. Lawrence, J. E., et al., 2013. *Hyporheic zone in urban streams: A review and opportunities for enhancing water quality and improving aquatic habitat by active management*. Environmental Engineering Science, 30(8), 480-501.
48. Livesley, S. J., et al., 2021. *Water smart cities increase irrigation to provide cool Refuge in a climate crisis*. Earth's Future, 9(1), e2020EF001806.
49. Dosskey, M. G., et al., 2010. *The role of riparian vegetation in protecting and improving chemical water quality in streams*. Journal of the American Water Resources Association, 46(2), 261-277.
50. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.

It is also important to note the health-related costs of poor urban water quality. This includes both the medical costs of illness caused by exposure to poor water quality, and the health and wellbeing impacts resulting from the loss of amenity caused by extended periods of poor water quality. This is particularly a concern for blue-green algal blooms and water odours which impact not only on ability to engage in primary contact activities but also to enjoy shore-based activity such as walking and social interaction.

## We can't have our lake and heat it

Health impacts of climate change in an urban water context

It is likely that as the ACT's population grows and a higher density of living is promoted, there will be increased pressure on waters for recreation. This includes both primary contact (e.g. swimming), and secondary contact (e.g. fishing) activities, as well as waterside walks, cycle rides and picnics. Semi-natural areas within easy reach of city residences will be in increasingly high demand as our climate warms and urban greenspace is diminished by infill developments. Conversely, the pressures of climate change and urbanisation also threaten the utility of these areas for recreation.

Higher nutrient loads combined with longer warm periods means that cyanobacterial blooms are likely to increase in magnitude and frequency as the climate warms, including outside of the summer months. Blue-green algae (also known as cyanobacteria) are micro-organisms that produce toxins which pose significant risks to human and animal health when their concentrations are high. Cyanobacteria can grow more rapidly at higher temperatures and waterbodies are more likely to stratify at higher temperatures, which again creates favourable conditions for blue-green algal growth[51,52]. This results in frequent lakes closures to primary contact when blue-green algae concentrations are high (refer to sections on lakes for percentage of closures). The additional risk of cyanobacterial blooms is likely to coincide with the increased recreational demand for our urban lakes, particularly as the climate continues to warm. This means that Canberra's urban lakes will increasingly be unsuitable for swimming at the times of year when people are most likely to want to swim. Rivers downstream of Canberra may also be similarly affected as they receive inflows of blue-green algae affected water from our urban lakes.

51. Håkanson, L., Bryhn, A. C., and Hytteborn, J. K., 2007. *On the issue of limiting nutrient and predictions of cyanobacteria in aquatic systems*. Science of the total environment 379(1): 89-108.
52. O'Neil, J. M., et al., 2012. *The rise of harmful cyanobacteria blooms: The potential roles of eutrophication and climate change*. Harmful Algae 14: 313-334.

Most concerns about blue-green algae relate to direct contact with or ingestion of the toxins. This can result in a range of symptoms from eye and skin irritation to gastrointestinal upset, and in extreme cases, death. Cyanobacterial blooms can also affect the amenity of lakeside areas, with frequent reports of unpleasant smell from Lake Tuggeranong in Canberra's media[53,54] over the summer months. In addition to this, there are increasing concerns about the links between neurodegenerative disorders and prolonged exposure to cyanotoxins simply from living near to waterbodies that experience algal blooms.[55] These kinds of risks are unlikely to be realised for tens of years, making developments on the shores of lakes that suffer regular blue-green blooms a potential source of poor health in the future. This should be a major concern for the managers of the waterbodies. In this context, the urban developments that have been occurring on the shores of Lake Burley Griffin and Lake Tuggeranong mean that the management of water quality in the lakes becomes particularly important.

As well as closures caused by blue-green algae, recreational waters in the ACT are also closed when bacterial counts are found to be high and therefore pose a potential risk to human health. A recent study by Vincent and Starrs[56] found a consistent association between high flows and **turbidity**[57] levels in the Murrumbidgee River, and elevated amounts of enterococci bacteria. A combination of urbanisation and climate change conditions in the ACT is likely to result in more frequent periods of high flow and turbidity, and potentially an increase in the number of days when lakes and rivers are closed to swimmers due to high bacterial counts.

53. Roberts, L., 2019. *Why does Lake Tuggeranong smell and look so foul?* https://the-riotact.com/why-does-lake-tuggeranong-smell-and-look-so-foul/290110. Riotact News, published on 10 March 2019.
54. Fuller, N., 2021. *Blue-green algae breaks out in warm autumn*. https://canberraweekly.com.au/canberra-blue-green-algae-outbreak-in-warm-autumn/. Canberra Weekly, published on 29 April 2021.
55. Fiore, M., et al., 2020. *Living near waterbodies as a proxy of cyanobacteria exposure and risk of amyotrophic lateral sclerosis: A population based case-control study*. Environmental Research, 186: 109530.
56. Vincent, K., et al., (accepted). *Relationships between extreme flows and microbial contamination in inland recreational swimming areas*. Journal of Water and Health.
57. Measure of relative clarity of a liquid, in this case, of water. Turbidity causes water to lose its transparency due to suspended particles.

## 4.5 Competing values of urban lakes and waterways

The multiple roles that Canberra's lakes and waterways play — stormwater management, water quality management, community amenity and ecosystem services — are the values held by urban waters. Each value confers a set of expectations for the way each waterway functions, the types of ecosystems they support, their ecosystem health, and water quality. For example, community expectations for improved water quality and uninterrupted opportunities for recreation in Canberra's lakes can be seen as contrary to the role the lakes play in protecting downstream waters by collecting urban runoff and the pollutants they contain.

While the 2016 Schirmer and Mylek[58] survey showed that the community values waterways in the ACT most highly for the opportunities they offer for walking, picnicking, cycling, and using playgrounds in the areas surrounding them, the management objectives for urban waterways do not consider such values. The Canberra Urban Lakes and Ponds: Land Management Plan describes the management objectives for Canberra's urban lakes and ponds from an ACT Government perspective, and the hierarchy of these objectives. These are to:

1. Prevent and control floods by providing a reservoir to receive flows from rivers, creeks and urban runoff.

2. Prevent and control pollution of waterways.

3. Provide for public use of the lake or pond for recreation.

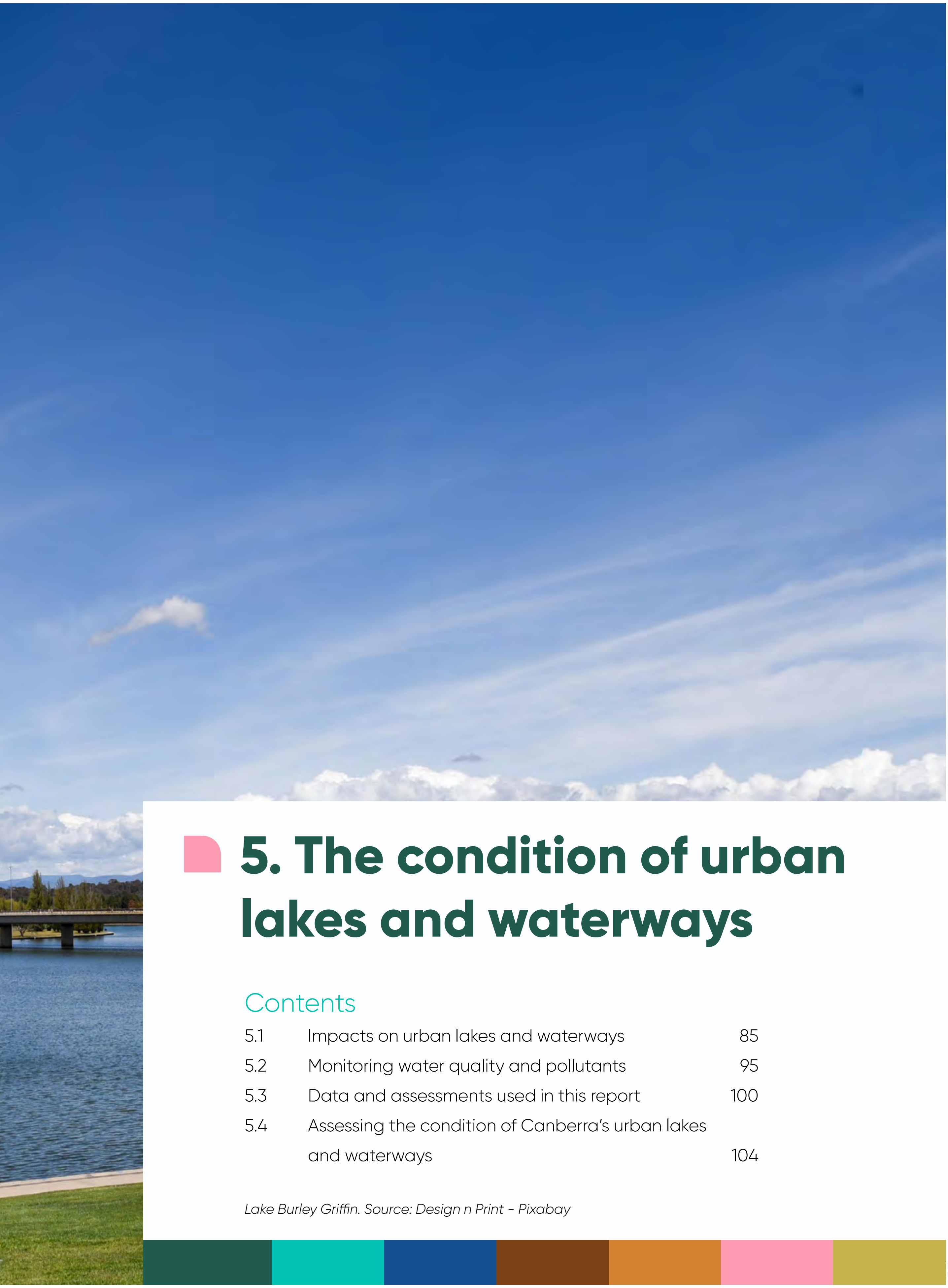
4. Provide habitat for fauna and flora.

Tensions around expectations are neatly summed up in a quote attributed to Professor Peter Cullen in the OCSE 2012 report on Lake Burley Griffin:[59]

> *'Lake Burley Griffin is the largest gross pollutant trap in the southern hemisphere. It is a large lake collecting stormwater from a large part of Canberra and all of Queanbeyan, as well as treated effluent from the Queanbeyan sewage treatment plant. If that is its primary role — to prevent pollution reaching the Murrumbidgee River — it is functioning correctly: we should expect to see what is happening as the pollution is trapped. If, as a community we want to use it for recreation, then we should expect additional recreational use to cost the community an additional amount to ensure it is safe and functional for that higher level of use.'*

It is because the expectations for urban waters differ so widely, that urban waterway management remains a contentious issue in Canberra.

58. Schirmer, J., and Mylek, M., 2016. *Water quality and the community: understanding the views, values and actions of residents of the ACT and surrounding region*. University of Canberra, Canberra.
59. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.



# 5. The condition of urban lakes and waterways

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*Lake Burley Griffin. Source: Design n Print - Pixabay*

## 5.1 Impacts on urban lakes and waterways

This section provides general information on the main impacts on Canberra's lakes and waterways, information that is important for the interpretation of the findings presented in this Investigation. Information on pressures specific to individual waterbodies is discussed in their relevant sections.

The main impacts on the aquatic health and values of Canberra's urban lakes and waterways are discussed below.

### The role of Canberra's lakes and ponds in water management

The role urban lakes, ponds and wetlands play in water management is itself an impact on the health and values of urban waters. Canberra's lakes and ponds are designed to receive stormwater from the surrounding suburbs and trap nutrients and other pollutants to prevent them from being passed downstream into the Murrumbidgee River. The smaller urban ponds and wetlands that are spread throughout Canberra's suburbs are very effective at trapping nutrients and other pollutants when the flow in the stormwater network is low. At high flows, the lakes and large ponds trap the much greater volumes of water and pollutants. While the ability of our lakes to trap nutrients and other pollutants is an important function, the downside is that over time, the pollutants accumulate in the lakes and ponds and the quality of water declines. Nutrients pose particular problems because high concentrations support the growth of cyanobacterial blooms.

### Climate change

Climate change is the most significant environmental challenge facing urban water management, as it will strongly intensify the effects of all the threats and pressures described elsewhere in this report. Reduced rainfall, hotter temperatures and increased evapotranspiration all have severe consequences, including:

- reduced flows and reduced wetland inundation
- reduced deep water habitat refuges
- higher water temperatures and lower dissolved oxygen concentrations
- extended dry periods punctuated by severe storms which result in large nutrient, sediment and other pollutant pulses
- increased algal blooms, and
- more frequent and severe bushfires which compromise water quality and riparian vegetation.

Although the aquatic species of the ACT are well-adapted to extremes of floods and droughts, projected changes will pose significant challenges for the management of water quality. Changes in temperature and rainfall will affect runoff patterns and stream flows, changing the way in which pollutants and contaminants are generated and transported through the stream network. Hotter conditions, and more frequent and severe droughts will decrease the amount of water flowing through waterways and into lakes, ponds and wetlands. Long periods of reduced water flows have been shown to have significant impacts on ecosystem health and biodiversity. Hotter conditions also mean increased evaporation and evapotranspiration across the landscape, resulting in less water in our soils, vegetation and waterways. This in turn will increase the risk of bushfires and the impacts on waterways that fires bring.

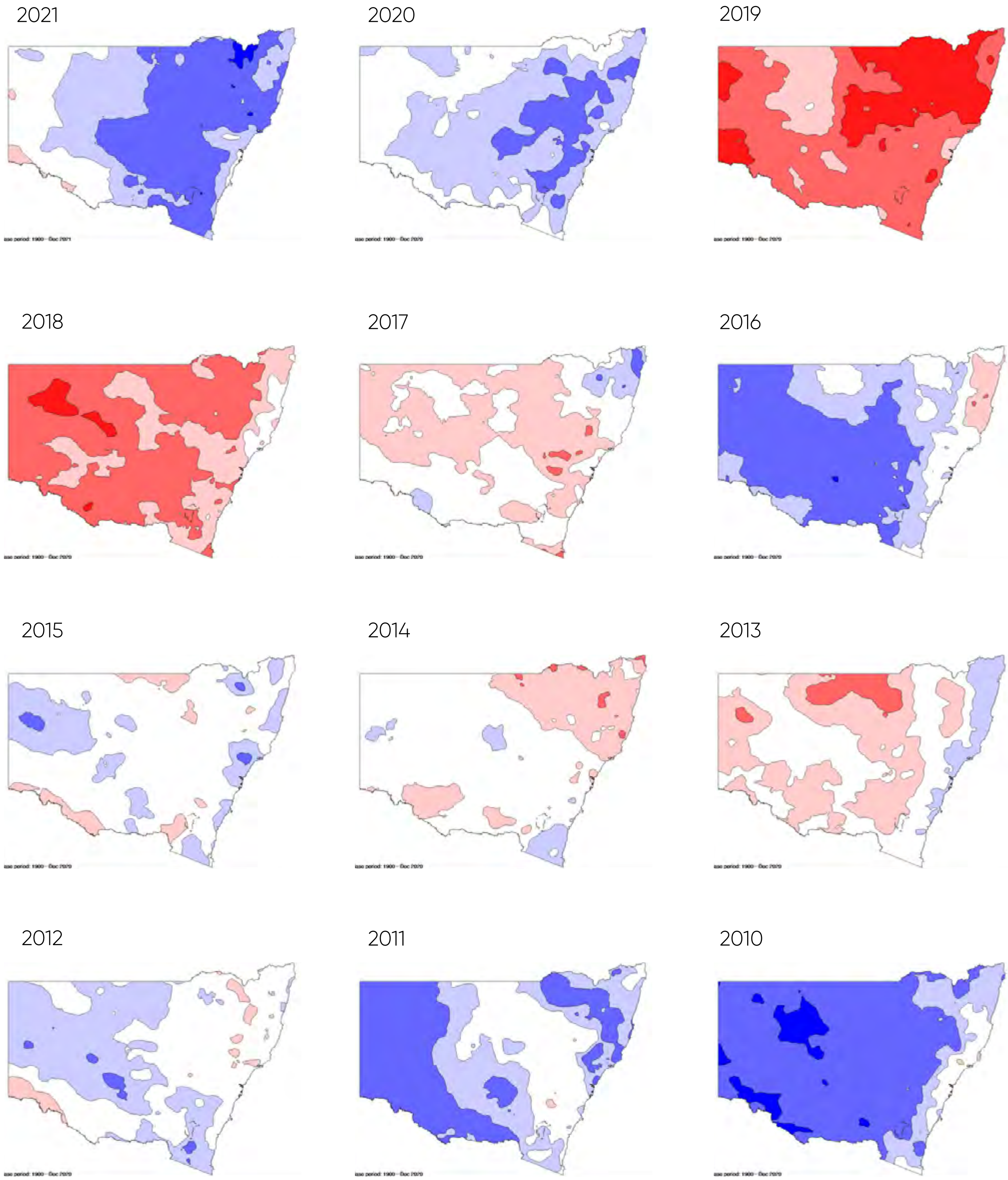
Longer and more severe droughts will reduce groundcover vegetation, leaving areas of bare ground susceptible to erosion. Such long dry spells will also result in an accumulation of organic matter, pollutants and contaminants on impervious surfaces. Drought-breaking rains are likely to cause significant erosion, which will increase turbidity and contribute an increased load of nutrients and other pollutants entering urban waterways. In the long term, the pressures of climate change on aquatic ecosystems could lead to significant and long-lasting changes in the species present in urban lakes, ponds, wetlands and waterways in the ACT.

## Weather context for the assessment period

Because weather has a significant influence on water quality and aquatic ecosystem health, it is important to acknowledge the weather experienced by the ACT over the assessment period used in this report (2010–2021).

The past decade has been characterised by a series of extremes in weather conditions across the ACT (Figure 5.1 and Figure 5.2). Temperatures have been above to well above average in eight of the 10 years from 2010 to 2020 and rainfall has been highly variable. Very wet conditions prevailed from 2010 to 2012 as the Millennium Drought broke, and wet conditions also occurred in 2016 and 2020. The period from 2017 to 2019 was increasingly hot and dry, culminating in the hottest year on record in 2019 leading into the major summer bushfires of 2019–20.

Such weather extremes place waterways under considerable stress, with stream flows ranging from some of the highest to lowest on record. The large variation in weather conditions also increases pollutant loads, particularly when extended dry periods are punctuated by heavy rainfall resulting in large nutrient, sediment, and other pollutant pulses.



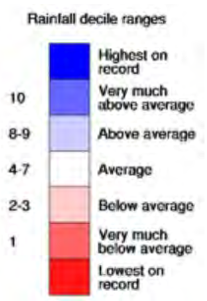
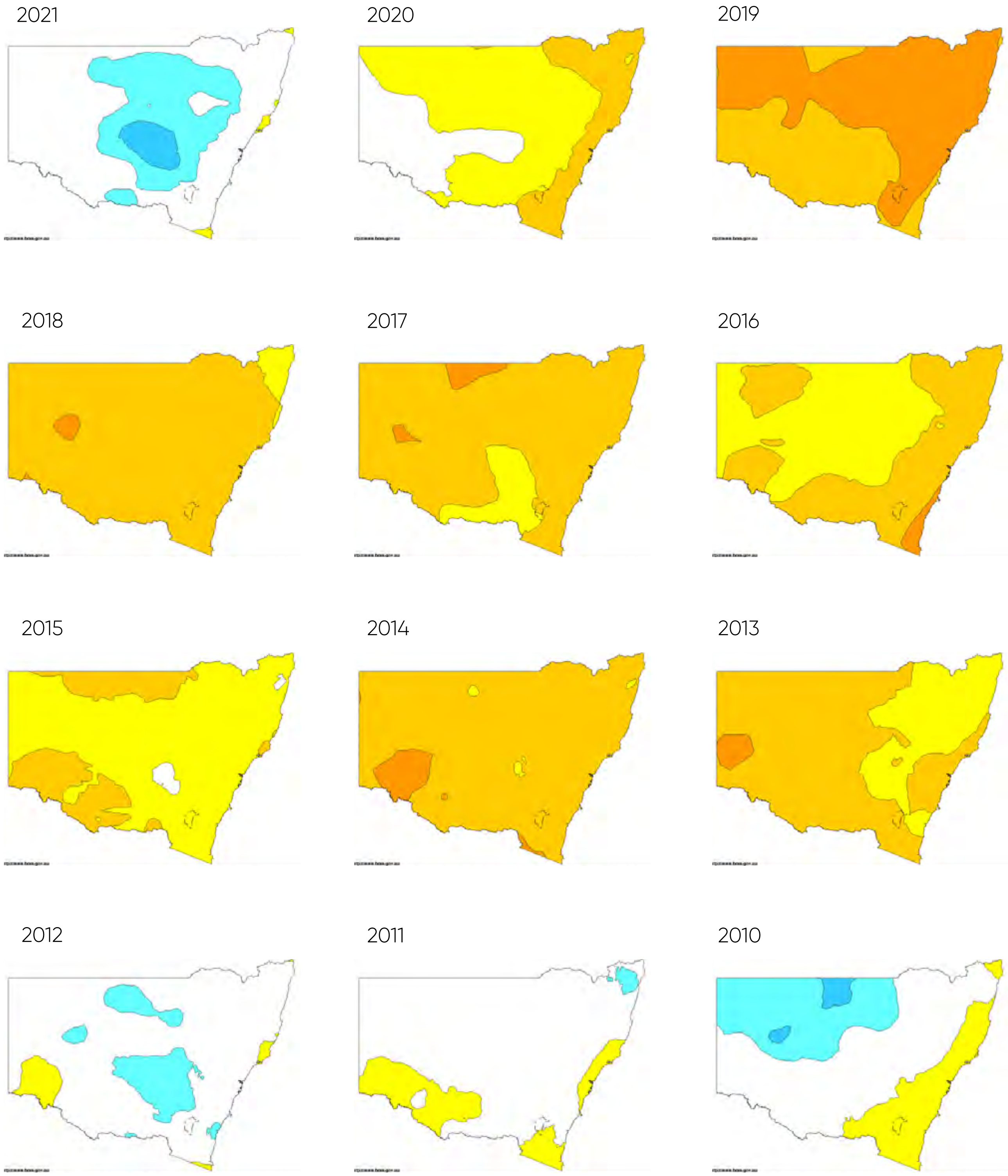




**Figure 5.1.** Rainfall decile ranges for NSW and the ACT from 2010 to 2021.

**Source:** Bureau of Meteorology (www.bom.gov.au/climate/maps/)



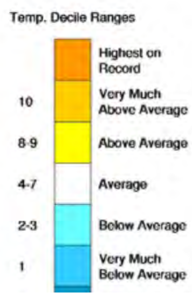




**Figure 5.2.** Temperature decile ranges for NSW and the ACT from 2010 to 2021.

**Source:** Bureau of Meteorology (www.bom.gov.au/climate/maps/)

## Urban stormwater

The urban environment poses significant challenges for the management of lakes and waterways. Urban areas are characterised by a concentration of housing, commercial centres, construction and industrial activities, roads and areas of degraded land. These areas contain a suite of urban pollutants, including sediment, nutrients, bird and animal droppings, leaves and grass clippings, rubbish, microplastics, heavy metals, and chemicals such as fertilisers, biocides, fuel and oil. These pollutants are transported to urban waters in the urban runoff generated by rainfall events and end up trapped in ponds, wetlands and lakes. The more intense the rainfall, the more pollutants that are collected and transported. This makes the occurrence of storms particularly problematic for urban waters. The increased flows and highly polluted waters associated with urban stormwater pose risks to people and infrastructure, and degrade aquatic health (see **Urban stormwater runoff and management in the ACT** infographic in Chapter 2).

Urban runoff pollution is exacerbated by the piped stormwater drains and impermeable land surfaces (Figure 5.3). These increase the volume and velocity of stormwater compared to corresponding natural streams and carry greatly increased pollutant loads.

*Stormwater channels in the LakeTuggeranong catchment. Source: Miranda Gardner*

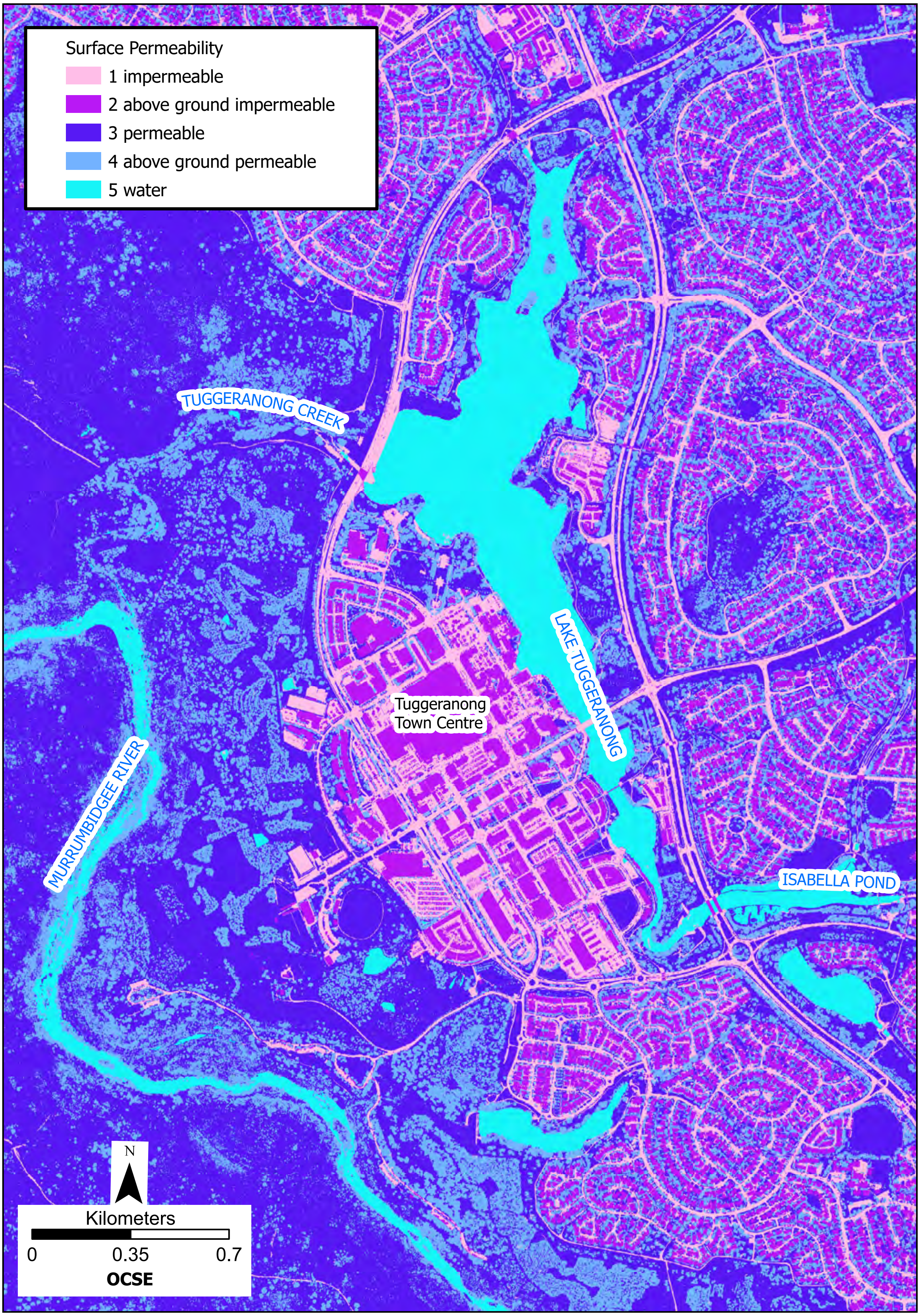



**Figure 5.3**: Surface permeability Lake Tuggeranong area.

**Data sourced from:** ACT Government

## Land use change and modifications to waterway channels

Many of Canberra's natural waterways have been modified to manage flood risk. This includes the construction of stormwater pipes, concrete channels and concrete swales (Figure 5.4) with grassy banks to quickly remove large volumes of urban runoff.[60] These have resulted in the loss of the habitat and landscape values of urban waterways through the physical modification of the natural channels and removal of riparian vegetation. Such modifications can impact on aquatic health by:

- stopping the natural physical and biological processes performed by the interaction of water, natural stream channels, and surrounding vegetation
- altering natural flow regimes and increasing the occurrence and severity of peak flows
- removing instream habitat including instream woody debris
- removing riparian habitat, reducing connectivity and functions such as shading, channel protection and food resources
- increasing water quality impacts by removing the biological processes of soils, aquifers and streams that naturally reduce the concentrations of sediment and other pollutants
- increasing the impacts of drought through higher water temperatures (especially in open concrete systems and where riparian vegetation has been cleared), reduced aquifer recharge, and greater risk of algal blooms
- creating barriers to the movement of fish and other species, and
- supporting the introduction of exotic species.

These impacts not only degrade aquatic health, and aquatic and terrestrial biodiversity but also have consequences for human wellbeing through the loss of amenity and aesthetic qualities.

Although the majority of Canberra's waterway modifications were undertaken decades ago, new urban developments continue to threaten the health of lakes and waterways. Many such new developments in Canberra result in modifications to existing waterways and drainage lines to reduce flood risk, meet the desired urban layout, create amenity value, and to provide sufficient depth to allow stormwater pipes to drain to the waterway.

Particularly concerning is the construction stage of new developments which has been shown to have serious consequences on Canberra's aquatic systems, particularly through sedimentation impacts. The proximity of developments to the Lower Molonglo and Murrumbidgee Rivers makes such impacts even more concerning. More information on urban development and sedimentation issues is presented in **Chapter 12: Urban development and the ACT's lakes and waterways**.

60. It should be noted that constructed lakes, ponds and wetlands also reduce flood risk.

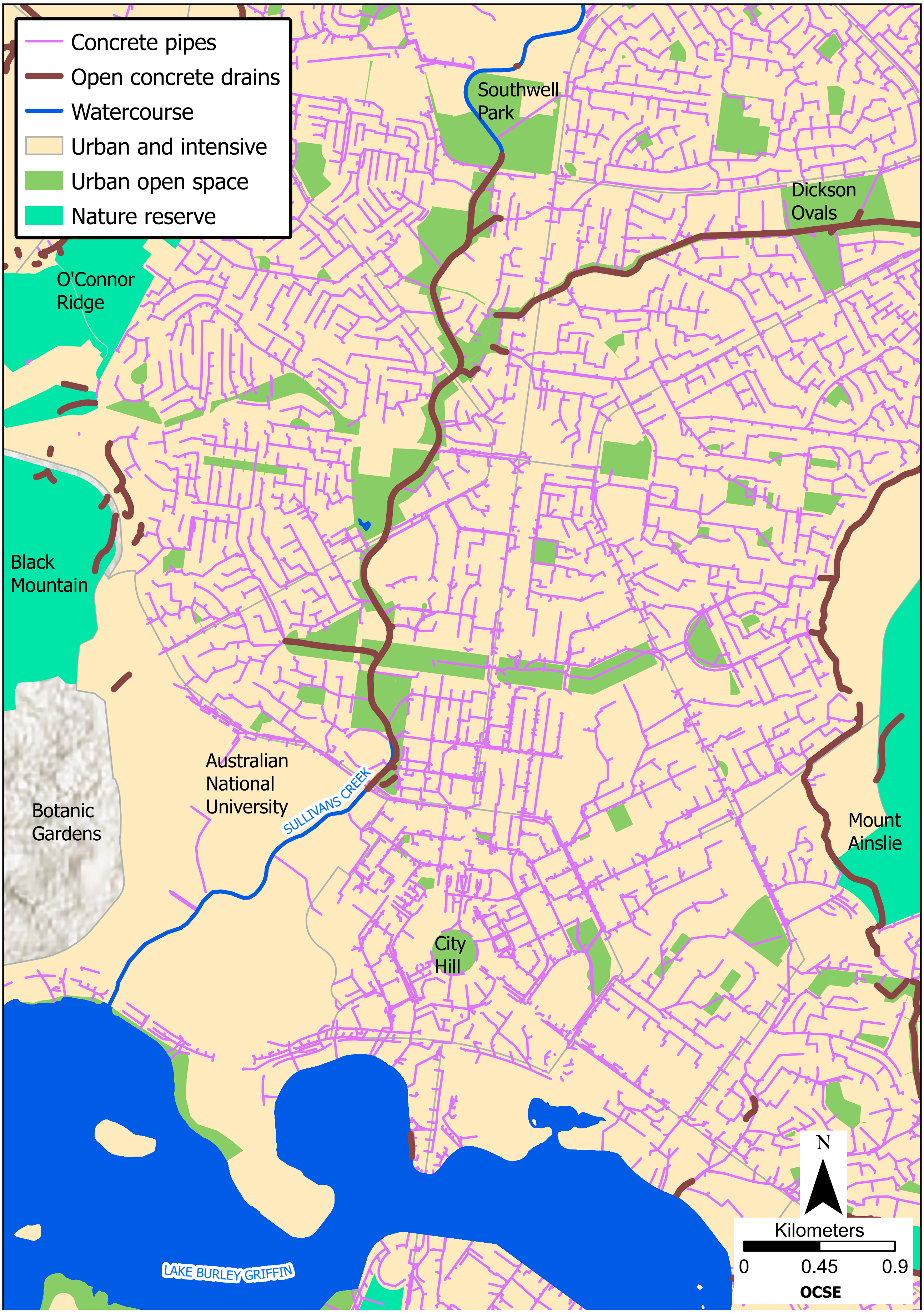



**Figure 5.4:** Concrete pipes and open concrete drains in a section of the ACT's inner north.

**Data sourced from:** ACT Government

### Rural catchments

Rural lands are interspersed throughout the upper and lower reaches of Canberra's urban waterways. For example, the Molonglo River and Lake Burley Griffin catchments upstream of the ACT are dominated by rural land uses. Impacts from rural areas are similar to those of urban areas with increased rainfall runoff and pollutant loads, as well as the loss of instream and riparian habitat. Areas with agricultural production can have significant impacts on aquatic ecosystems. For example, native vegetation clearance for cropping and grazing has led to increased soil erosion and the potential for chemicals and animal waste to enter waterways. These compromise water quality through sedimentation, elevated nutrients, increases in bacteria such as enterococci, the introduction of potentially toxic chemicals, and the erosion of stream banks. Forestry activities in rural areas can also impact on aquatic ecosystems, particularly through erosion and increased runoff following harvesting operations and the introduction of roads.

### Sewage treatment discharges

Sewage treatment discharges introduce additional nutrients, salts and a range of other pollutants into receiving waters. Whilst treated effluent discharges may have a lower impact than diffuse sources of pollution, sewage overflows caused by damaged infrastructure or flood events are an occasional concern. The discharge of untreated or partially treated effluent can introduce harmful pollutants to waterways, including high levels of nutrients and pathogens. It can take several weeks for high pollutant levels to disperse.

The ACT urban waters impacted, or potentially impacted, by sewage effluent include:

- discharges from the Queanbeyan Sewage Treatment Plant (QSTP) into the Molonglo River and Lake Burley Griffin
- potential overflow discharges from designed overflow points or sewage pumping stations (for example, overflows from the City West Overflow Detention Facility into Sullivans Creek)
- discharges from the Captains Flat (NSW) sewage treatment plant into the upper Molonglo River, and
- possible contamination of the Molonglo River from Onsite Sewage Management Systems in the Queanbeyan-Palerang area.

For treated effluent discharges, the QSTP remains the most significant threat to the health of Canberra's urban waters. For more information on the impacts of sewage treatment discharges see section **Lake Burley Griffin (6.1.2)** and **Molonglo River (7.1.1)**. The QSTP is being replaced with a new plant, with completion estimated in 2024, for more information on the new QSTP and its potential impacts on Lake Burley Griffin and the Molonglo River see **Chapter 12: Urban development and the ACT's Lakes and waterways**.

## Invasive species

Invasive species have significant impacts on aquatic ecosystem health and biodiversity. Invasive plants can outcompete and displace native species in riparian zones and within urban waters themselves. Urban development in Canberra has significantly increased the spread of invasive plant species over the past 30 years. The riparian zone for many urban creeks is dominated by exotic grasses with a mix of native and exotic mid-storey and canopy. Some notable exceptions are areas where Landcare groups have been working for many years. Invasive plants can compromise bank stability and prevent the establishment of native species that provide benefits such as habitat and shade for waterways.

Invasive fish species including European Carp, Eastern Gambusia, Oriental Weatherloach and Redfin have significant impacts on both native species and water quality. They can displace native fish through predation, competition and the introduction of disease. For example, European Carp feed by disturbing the bottom sediments of waterbodies which causes sediment resuspension and disturbance of aquatic vegetation. The resulting increased turbidity and loss of aquatic plants can have substantial effects on aquatic ecosystems. Redfin Perch are an aggressive predatory species that target smaller fish species and invertebrates. They also carry the epizootic haematopoietic necrosis virus which is detrimental to native fish species. Eastern Gambusia are prolific in smaller waterways and impact on the biodiversity through aggression towards tadpoles and smaller fish.

## Recreation

Urban lakes and waterways can be impacted by recreation activities. Trampling of vegetation, track erosion, damage from recreational vehicles, bank erosion from boat wakes, the introduction of invasive species, littering, water pollution, recreational fishing (illegal take, not clearing away fishing rubbish such as lines, hooks, and dead fish), increased fire risk, and uncontrolled pets can all threaten aquatic ecosystem health and biodiversity.

## Fire

Although fire is not considered a high risk for most urban waters, upper catchment areas can be significantly impacted by fire with consequences for downstream urban waters. Bushfires remove vegetation cover, exposing and altering the structure of soils and increasing the risk of significant erosion. Rainfall and runoff after bushfires can deposit large volumes of sediment, ash and metals into aquatic ecosystems. These deposits degrade water quality by increasing turbidity and nutrient concentrations, and can reduce dissolved oxygen concentrations causing the loss of fish and macroinvertebrates. Large amounts of sediment and ash can also smother instream habitat.

Severe fires can also result in the loss of riparian vegetation, and the habitat, shade and food resources that this vegetation provides.

It should also be noted that a changing climate impacts all aspects of bushfire risk. The ACT is projected to experience an increase in average and severe fire weather days, mainly in summer and spring.[61]

61. NSW Office of Environment and Heritage, 2014. *Australian Capital Territory Climate change snapshot*. NSW Department of Planning and Environment, Sydney.

## 5.2 Monitoring water quality and pollutants

Water quality is highly sensitive to a range of factors including land use, flow regimes and the loss of riparian vegetation. Good water quality is critical to the ecosystem services that rivers provide for a range of social, economic and environmental needs. Poor water quality can lead to the loss of aquatic species, human illnesses and the loss amenity from the closure of recreational water bodies, and odour.

Sources of water quality pollutants can be broadly classified as point (directly from industry and sewage treatment plants) or diffuse (runoff from catchments). Following significant improvements in the regulation of point source pollution, diffuse sources are generally the main cause of poor water quality in the ACT. However, during low flow periods, point source pollution such as the Queanbeyan Sewage Treatment Plant can be a significant source of water pollutants.

The main water pollutants monitored in the ACT and used for this Investigation are:

- **Turbidity:** A measure of water clarity. High levels of turbidity (water with poor clarity) can be caused by inorganic matter such as sediment, clay or silt, and by organic matter such as algae, microscopic organisms and dissolved organic compounds. For inorganic matter, erosion is the main cause of turbidity problems, with significant occurrences following storms that erode soils. Turbidity reduces light penetration affecting the ability of aquatic plants to photosynthesise and impairing animal activities such as predation. Related, but not typically monitored in the ACT is **sedimentation**, or the amount of inorganic matter in water. At very high levels, suspended sediment can clog and damage fish gills and the filter-feeding apparatus of animals such as mussels. Large-scale sediment deposition can smother river habitats creating shallow flow areas that are subject to greater temperature extremes and the risk of invasion by aquatic weeds.
- **Nutrients:** Although nitrogen and phosphorus are essential plant nutrients, elevated concentrations can cause excessive plant growth (eutrophication), including toxic algal blooms which are the main cause of recreational water closures. Algal blooms can also cause the deaths of fish and other species by decreasing dissolved oxygen concentrations. The major cause of increased nutrient levels is runoff from urban and agricultural catchments, particularly in areas with high fertiliser usage. Point sources of pollution, such as discharges from agriculture, industry and wastewater treatment plants, also have elevated concentrations of phosphorus and nitrogen. Nutrients can be in dissolved form or attached to particulate matter in the water. Nutrients can also be released from sediments in Canberra's urban lakes in response to conditions such as low oxygen concentrations.
- **Organic matter:** Whilst the input of organic matter, such as leaves and other plant debris, is essential for aquatic systems, urban runoff can result in large loads of organic matter being deposited into urban waters. High amounts of organic matter can lead to significant decreases in the dissolved oxygen concentrations of water causing the death of fish and aquatic invertebrates. Low oxygen conditions and the leaching of nutrients from organic matter can also result in elevated nutrient levels causing algal blooms. For example, the runoff of organic matter from urban catchments has been identified as a major cause of blue-green algae blooms in Canberra's urban lakes.

- **Salinity:** Salinity, also known as conductivity, is the salt concentration in water. High salt levels are a direct threat to aquatic ecosystems. While some aquatic species tolerate a range of salt concentrations, changes in salinity can kill a wide range of plants and animals.
- **pH:** pH is the measure of acidity and alkalinity of water. Runoff can negatively affect pH, potentially changing it to a level that will reduce water quality to unacceptable levels. Changes in natural pH levels can result in the mortality of aquatic species. Decreases in pH (more acidic) can also increase the bioavailability of heavy metals, which is particularly relevant to Lake Burley Griffin and its legacy of heavy metal pollution in sediments.
- **Dissolved oxygen:** Dissolved oxygen is the concentration of oxygen in the water and is important for the survival of aquatic organisms. Low oxygen levels can stress fish, which can lead to fungal infections and disease or result directly in the death of fish and other aquatic species. Dissolved oxygen concentrations are particularly affected by temperature (warmer water holds less dissolved oxygen) and severe declines occur following algal blooms. It is important to note that any periods of low dissolved oxygen can have significant impacts on aquatic species. For example, even short periods of extremely low dissolved oxygen concentrations can result in the deaths of fish and macroinvertebrates.

*This Investigation only reports on the pollutants used for monitoring programs in the ACT – turbidity, suspended solids (urban ponds and wetlands only), phosphorus, nitrogen, salinity, pH and dissolved oxygen, as well as the recreational water testing for blue-green algae and enterococci. This means that other commonly occurring pollutants are not included in this Investigation. For example, there are a range of non-monitored pollutants found in urban and rural runoff including metals, oils, fats, microplastics and toxic chemicals, such as herbicides and pesticides. Sewage treatment discharges can also contain a range of chemicals including endocrine disrupting compounds. All these pollutants can have significant impacts on aquatic and human health. In the absence of data for non-monitored pollutants, it is not possible to determine the full range of impacts on the quality and health of Canberra's urban waters.*

## Recreational water quality

Recreational water quality refers to the suitability of water for swimming and other activities that involve direct contact with the water. Canberra's lakes and rivers are important for providing amenity and opportunities for recreation. However, this type of use is dependent on good recreational water quality.

Assessments of recreational water quality are based on measurement of faecal indicator bacteria (enterococci), and on the concentration of blue-green algae (cyanobacteria) which are potentially poisonous to humans or animals. Enterococci are not necessarily a problem for aquatic ecosystems, as they generally serve as food for aquatic organisms without causing them harm. However, the presence of high enterococci numbers can affect human health when recreational activities involve direct contact with the water. Ingestion of these bacterial pathogens can lead to gastrointestinal illnesses such as diarrhoea.

Blue-green algae are naturally present in aquatic ecosystems but under certain conditions their populations can increase causing a potentially toxic bloom. Low river flows, high temperatures and high levels of nutrients are the primary causes of blue-green algal blooms. The blooms can produce toxins that are harmful to humans and animals when they are swallowed, inhaled or come into direct contact with the skin. Reactions are variable, depending on the length and type of contact. Common symptoms include irritated skin, flu-like symptoms and gastrointestinal illness resulting in vomiting, diarrhoea, fever and headache.

## Causes of poor recreational water quality

The high number of recreational site closures because of enterococci shows that urban and rural runoff is depositing high levels of this bacteria into the ACT's lakes and waterways. Urban and rural runoff is also the main driver of recreation closures caused by blue-green algae. Rainfall runoff transports high amounts of nutrients and organic matter into lakes and other waterways enabling algal blooms to occur.

Key to reducing algal blooms and bacterial contamination is improving the effectiveness of urban runoff interception and pollutant removal. This will require additions to the current water sensitive urban design infrastructure, as well as improving the performance of such infrastructure. It should be noted that water quality improvements are likely to take many years, particularly for measures to reduce nutrient concentrations. In addition, the improved management of rural lands is required including the prevention of livestock access to waterways, and reduced erosion and sedimentation.

The occurrence of algal blooms is also driven by climate factors such as extended dry periods and hotter temperatures. With these conditions set to increase as a result of climate change, reducing the amount of nutrients in lakes and waterways will be required to prevent longer and more frequent recreation closures in the future.

## Recreational water quality monitoring in urban lakes

Recreation water quality monitoring is undertaken in accordance with the ACT Guidelines for Recreational Water Quality across four sites in Lake Ginninderra, three in Lake Tuggeranong and two on the Molonglo River. Recreational water quality is also assessed at 10 sites in Lake Burley Griffin by the National Capital Authority.

Water samples are taken weekly during the recreational swimming season (between approximately October and April) for enterococci and throughout the year for blue-green algae. If samples for enterococci and blue-green algae exceed guideline levels, then a resample is obtained and tested. If two consecutive samples exceed guideline levels, then the site is closed for primary contact. Reopening a recreational site after a closure requires two samples within guideline levels.

## Biological monitoring

Biological monitoring is the assessment of aquatic flora and fauna such as native fish, macroinvertebrates, algae, and aquatic and riparian vegetation. These provide an indication of the health of aquatic ecosystems and evidence of poor water quality, degraded habitat, changes to flows and the impacts of invasive aquatic species.

Apart from the monitoring of algae for recreational water quality, macroinvertebrate and riparian assessments are the most common form of biological monitoring in the ACT. These are used to inform this Investigation.

### Macroinvertebrates

Aquatic macroinvertebrates are a diverse group of insects, crustaceans and molluscs that include dragonflies, stoneflies, snails, yabbies, water boatmen and worms. They are relatively sedentary and spend at least part of their life in aquatic ecosystems. Macroinvertebrates are critical to aquatic ecosystem health: they are an important food source for fish and other species such as platypus, and are critical to ecosystem processes such as nutrient cycling. Because macroinvertebrates are widespread, easy to sample and sensitive to a range of pressures, they are routinely used as indicators of the condition of aquatic systems and their surrounding catchments. Land use change, aquatic and riparian habitat modification, water pollution and river regulation all affect macroinvertebrate community health.

### Riparian vegetation

The riparian zone is the land and vegetation that fringe aquatic ecosystems. Such zones are vital for aquatic health as they provide habitat, stable banks, shade, buffers and filters for incoming runoff, reducing sediments, nutrients and pollutants, and food for aquatic species. The loss and degradation of riparian zones compromises both aquatic and terrestrial biodiversity. They are particularly important during drought periods, providing refuge for terrestrial species and helping to reduce the impacts of low flows on aquatic systems. Riparian vegetation is often the only native vegetation remaining in heavily modified landscapes, making them vital wildlife corridors.

### Fish

Although fish monitoring data were not available for this Investigation, information is provided on native fish stocking, the presence of native and invasive fish species, and the occurrence of fish kills. This information provides some indication of the status of fish in Canberra's urban waters. Knowledge on fish populations also provides feedback on whether urban aquatic ecosystem health is sufficient to support fish survival, especially with regard to known pressures such as poor water quality (turbidity, sedimentation, low dissolved oxygen concentrations and warmer water temperatures), and the loss of riparian vegetation.

The native fish community in all of Canberra's urban lakes and selected ponds is highly managed with regular stocking as part of the ACT Government *Fish Stocking Plan*.[62] Stocking is undertaken to provide a recreational fishery that is easily accessible to Canberrans. Focus is on stocking the lakes with charismatic native recreational fishing species (Golden Perch and Murray Cod), with fingerlings introduced towards the end of each calendar year. Stocking is required to maintain populations of native fish species because the lakes do not provide the appropriate conditions for breeding, mainly because of the lack of flowing water and suitable habitat required for successful breeding.

As noted in the section on 'invasive species', many urban waters are dominated by invasive species which have negative effects on water quality and native fish species. European carp feed by disturbing the bottom sediments of waterbodies which causes sediment resuspension and disturbance of aquatic vegetation. The resulting increased turbidity and loss of aquatic plants can have substantial effects on river ecosystems. Redfin Perch are an aggressive predatory species that target smaller fish species and invertebrates. They also carry the epizootic haematopoietic necrosis virus which is detrimental to native fish species.

*Golden Perch fish stocking in an urban lake. Source: Mark Jekabsons, ACT Government*

62. Environment and Planning Directorate, 2015. *Fish stocking plan for the Australian Capital Territory 2015–2020*. ACT Government, Canberra.

## 5.3 Data and assessments used in this report

### Data limitations

The findings of this Investigation need to be considered in the context of the current monitoring data limitations. Those limitations, discussed below, mean it is highly likely that the monitoring results will not reflect periods of high pollutant loads; that the true severity of water pollution in ACT urban waters and its impacts on aquatic health is unlikely to be accurately determined with the available data for this Investigation.

By way of explanation, water quality in any individual lake or waterway can be highly variable between sampling site locations and between sampling periods, given its dependence on a range of conditions including weather, activities in the catchment and pollution events. Water quality also depends on a range of natural features such as the presence/absence of aquatic and riparian vegetation, proximity to inflows, depth and flow velocity. Other factors such as wind conditions are also important for water quality in lakes.

Routine water quality monitoring (based on set time intervals) often misses significant pollution events – water quality can change quickly in response to the prevailing conditions within a catchment, and pollutant loads can decrease rapidly after events occur. For example, high levels of pollutants from stormwater runoff events are unlikely to be detected by routine monitoring unless, by chance, sampling is undertaken during or shortly after such an event. This means that the results of routine monitoring are often biased toward more favourable water quality assessments, rather than reflecting the actual condition of water quality and catchment pressures.

Therefore, water quality monitoring undertaken at regular intervals, mostly monthly in the ACT, is not sufficient to accurately assess water quality. To understand the sources and volume of pollutants, more frequent monitoring needs to occur, or preferably there needs to be events-based monitoring that assesses periods of high pollutant loads.

### 5.3.1 Data sources

This Investigation has drawn on data from a wide range of sources to assess the state of the ACT's waterways. While the available data are limited in spatial and temporal resolution, in combination they provide reasonable coverage of Canberra's urban waters.

The primary data sources are the ACT Water Quality database (water quality, recreational water quality and macroinvertebrates), the ACT Waterwatch database (water quality, macroinvertebrates and riparian condition), and the Urban Stormwater Research data set (water quality) from the University of Canberra. Lake Burley Griffin data were sourced from the National Capital Authority (water quality and recreational water quality). Data was augmented with meteorological and stream discharge data from the Bureau of Meteorology, and spatial data sets from the ACT and NSW Governments.

Water quality and ecological data were reviewed to ensure that the monitoring sites used had continuous or frequently collected data for the 2010 to 2021 reporting period. Additional data sets (where available) were used to improve understanding in particular catchments or locations.

Ecological data for the ACT's urban waterways is particularly rare. Long term macroinvertebrate data sets are available for selected sites within the urban stream network and these data provide some insight as to the water quality conditions. Waterwatch also assesses riparian condition for some urban waters. However, this approach is not suitable for areas of managed parklands. The ACT Government maintains data on fish stocking and fish kills in urban waters.

> *It is notable that this Investigation relies heavily on Waterwatch data for spatial coverage. The monitoring by Waterwatch and its community volunteers makes a vital contribution to the understanding and management of the ACT's waterways, including urban waters.*

### 5.3.2 Data assessments

The condition assessments used in this report are based on whether water quality results meet relevant guidelines, regulations and management plans. These may differ for each waterbody. Where ACT specific guidelines were unavailable, national water quality guidelines have been used. The following guidelines, regulations and management plans are used in this report.

#### Lake Burley Griffin

With the exception of dissolved oxygen, water quality parameters are assessed against guidelines in the *Lake Burley Griffin Water Quality Management Plan*.[63] This includes the cyanobacteria and enterococci assessments for recreational water quality.

Dissolved oxygen guidelines are not specified for Lake Burley Griffin, acceptable range assessments are based on *Environment Protection Regulation 2005 values for urban lakes and ponds*.[64]

63. National Capital Authority, 2011, *Lake Burley Griffin Water Quality Management Plan 2011*, National Capital Authority, Canberra.
64. Environment Protection Authority, 2005. *Environmental Protection Regulations*. ACT Government, Canberra.

## ACT recreational waters – Lake Tuggeranong, Lake Ginninderra and Molonglo River

Cyanobacteria and enterococci assessments are based on the *ACT Guidelines for Recreational Water Quality*.[65]

### Tuggeranong and Ginninderra lakes

With the exception of nitrogen and conductivity, water quality parameters are assessed against the:

- *Environment Protection Regulation 2005 values for urban lakes and ponds*[66]
- *Canberra urban lakes and ponds land management plan*.[67]

The ACT Government has not established default threshold (or guideline) values for nitrogen in the Tuggeranong and Ginninderra lakes. Consequently, this Investigation has applied the lower of the nitrogen guideline values established for Lake Burley Griffin (less than 1 milligram per litre).[68]

Conductivity results are assessed against the Australian and New Zealand Environment and Conservation Council (ANZECC), and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) 2000 default guideline values for slightly disturbed upland rivers.

### Urban streams

Phosphorus, pH, turbidity and dissolved oxygen water quality parameters are assessed against the *Environment Protection Regulation 2005 values for urban drains and streams*.[69]

Nitrogen and conductivity results are assessed against the ANZECC and ARMCANZ 2000 default guideline values for slightly disturbed upland rivers.

### Urban ponds and wetlands

With the exception of nitrogen and conductivity, water quality parameters are assessed against:

- Environment Protection Regulation 2005 values for urban lakes and ponds[70]
- Canberra urban lakes and ponds land management plan.[71]

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65. ACT Health, 2014. *ACT Guidelines for Recreational Water Quality*. ACT Government, Canberra.
66. Environment Protection Authority, 2005. *Environmental Protection Regulations*, ACT Government, Canberra.
67. Ibid.
68. National Capital Authority, 2011. *Lake Burley Griffin Water Quality Management Plan 2011*, National Capital Authority, Canberra.
69. Environment Protection Authority, 2005. *Environmental Protection Regulations*, ACT Government. Canberra
70. Ibid.
71. Environment, Planning and Sustainable Development Directorate, 2022. *Canberra Urban Lakes and Ponds Land Management Plan*. ACT Government, Canberra.

The ACT Government has not established default threshold (or guideline) values for nitrogen in urban ponds and wetlands. Consequently, this Investigation has applied the lower of the nitrogen guideline values established for Lake Burley Griffin (less than 1 milligram per litre).[72]

Conductivity results are assessed against the ANZECC and ARMCANZ 2000 default guideline values for slightly disturbed upland rivers.

More information on the specific acceptable ranges for water quality parameters can be found in the referenced guidelines, regulations and management plans referenced above.

## Nitrogen assessments

Methods for nitrogen measurement differs between water quality monitoring programs in the ACT. Waterwatch monitoring measures nitrate, whereas the ACT Government monitoring programs that undertake laboratory-based analysis measure total nitrogen. Because this Investigation uses Waterwatch and ACT Government data, both nitrate and total nitrogen is reported. The type of nitrogen assessment used in the findings is specified in the relevant supporting graphs included in the discussion.

Acceptable ranges for nitrogen have been establish for Lake Burley Griffin but not for the ACT's other urban waters, although a 12:1 nitrogen to phosphorus ratio is stated for urban lakes and ponds.[73] This Investigation has determined that the use of this ratio is inappropriate to determine the status of nitrogen levels in urban lakes and ponds. Consequently, this Investigation has applied the lower of the values established for Lake Burley Griffin to determine whether nitrogen levels exceed guidelines. The lack of an acceptable nitrogen range for ACT urban waters is a notable policy gap (see **11.4 Effectiveness of water quality policy**).

72. National Capital Authority, 2011. *Lake Burley Griffin Water Quality Management Plan 2011*. National Capital Authority, Canberra.
73. Environment Protection Authority, 2005. *Environmental Protection Regulations*. ACT Government, Canberra

## 5.4 Assessing the condition of Canberra's urban lakes and waterways

In the following chapters, the condition of Canberra's urban lakes and waterways is assessed. Background information on the lakes, waterways, ponds and wetlands assessed in this Investigation is provided in **Chapter 2: Background to Canberra's urban lakes and waterways** and their management is discussed in **Chapter 10: Management and governance of urban lakes and waterways**.

Assessments of water quality and aquatic health are used to evaluate whether each lake and waterway is meeting environmental, management and community expectations. These assessments provide evidence on the status of aquatic health and the effectiveness of environmental management policies and activities. The values assessed for each of the lakes and waterways included in this report will differ based on environmental and management objectives, as well as the community expectations associated with individual waters.

For each value, a graded assessment is provided using a dashboard display containing snapshots of key information including condition, trend and data quality. The dashboards should be read in conjunction with the content provided in each section. The graded assessment criteria are provided below.

**Indicator assessment legend**

**Condition**

| | |
|---|---|
| Good | = Environmental condition is healthy OR pressure likely to have negligible impact on environmental condition/human health/waterbody values. |
| Fair | = Environmental condition is neither positive or negative OR pressure likely to have limited impact on environmental condition/human health/ waterbody values. |
| Poor | = Environmental condition is under significant stress, OR pressure likely to have significant impact on environmental condition/human health/ waterbody values. |
| Unknown | = Data is insufficient to make an assessment of status and trends. |

**Trend**

| | |
|---|---|
| ↑ Improving | - Stable |
| ↓ Deteriorating | ? Unclear |

**Data quality**

| | |
|---|---|
| ●●● High | = Adequate high-quality evidence and high level of consensus |
| ●●○ Moderate | = Limited evidence or limited consensus |
| ●○○ Low | = Evidence and consensus too low to make an assessment |

Data availability, quality and comprehensiveness is a key limitation for the assessment of values. The data quality ratings provided in the dashboards provide a measure of the level of confidence in the assessments reported. If adequate high-quality data was available, confidence in the assessment is high. If data was limited, confidence is low. Where data was insufficient to enable an assessment, an unknown rating is applied.

Data availability issues are discussed for each of the urban waters reported, highlighting where more information is required to improve knowledge and management effectiveness.

Where relevant, the influence of significant climate and other events on data trends are discussed. It is important to note that such influences can impact on environmental condition and values regardless of management effectiveness.

# 6. Canberra's urban lakes

Contents



*Lake Burley Griffin. Source: Design n Print - Pixabay*

# 6.1 Lake Burley Griffin



*Lake Burley Griffin. Source: Ryan Colley*

### 6.1.1 Lake Burley Griffin main findings and key actions

## Condition assessment against management and community values

The values used to assess the state of Lake Burley Griffin are based on selected key requirements as outlined in the *Lake Burley Griffin Water Quality Management Plan*.[74] This includes assessing whether the water quality and aquatic health of Lake Burley Griffin support recreational activities including swimming, aesthetic and ecological values, and whether Lake Burley Griffin maintains downstream water quality and flow. The assessments are informed by the data findings discussed in section **6.1.3 Data trends for Lake Burley Griffin**.

74. National Capital Authority, 2011. *Lake Burley Griffin Water Quality Management Plan*. National Capital Authority, Canberra.

| Value | Status | Condition | Trend | Data quality |
|---|---|---|---|---|
| **LBG1**: Does the water quality in Lake Burley Griffin support recreational and aesthetic values? | Lake Burley Griffin is generally open for around 80 per cent or more of recreational seasons, and has been open for more than 90 per cent of the season in five of the past ten years. Cyanobacterial blooms are the main cause of recreational and aesthetic issues over the summer and autumn period. Cyanobacterial blooms are likely increasing, driven by high concentrations of nutrients in the lake and its sediments, as well as a warming climate which promotes the release of nutrients stored in the sediment. There are also periods of high turbidity in the lake following heavy rainfall in the catchment which further degrades recreational and aesthetic values. | Fair | ? | ●●● High |
| **LBG2**: Does the aquatic health of Lake Burley Griffin support ecological values? | There are limited data available to determine trends in the broader biodiversity and ecological values of the lake, although it is considered that the aquatic ecosystems have not changed markedly over the past 30 years. The loss of aquatic macrophytes since the 1980s has perhaps been the most significant change, suggesting that the lake is now dominated by phytoplankton rather than macrophytes. Extreme cyanobacterial concentrations have also increased over the past 10 years. The lake does provide valuable habitat for a variety of water dependent and terrestrial species, with water quality seen to support the stocked native fish populations. | Fair | ? | ●●○ Moderate |
| **LBG3**: Does Lake Burley Griffin maintain downstream water quality and flow? | **Water quality**<br>Lake Burley Griffin is effectively mitigating some of the effects of urbanisation, protecting the waters downstream of the lake for most of the time. The lake is trapping the additional phosphorus from the ACT's urban runoff, and limiting the potential effects of turbidity on downstream waters. Nitrogen is particularly well mitigated by the lake with lower concentrations found downstream. | Good | - | ●●● High |
| | **Flow**<br>Lake outflows were equivalent to inflows for all but the driest years when water was retained to maintain lake levels or to refill the lake. | Good | - | ●●● High |

## Indicator assessment legend

### Condition

- **Good** = Environmental condition is healthy OR pressure likely to have negligible impact on environmental condition/human health/waterbody values.
- **Fair** = Environmental condition is neither positive or negative OR pressure likely to have limited impact on environmental condition/human health/waterbody values.
- **Poor** = Environmental condition is under significant stress, OR pressure likely to have significant impact on environmental condition/human health/waterbody values.
- **Unknown** = Data is insufficient to make an assessment of status and trends.

### Trend

- ↑ Improving
- ↓ Deteriorating
- - Stable
- ? Unclear

### Data quality

- ●●● High = Adequate high-quality evidence and high level of consensus
- ●●○ Moderate = Limited evidence or limited consensus
- ●○○ Low = Evidence and consensus too low to make an assessment

## Lake Burley Griffin main findings

**Catchment land use**

- Lake Burley Griffin has a total catchment area of approximately 1,866 km$^2$, comprising a mix of land uses including urban (5%), rural (68%) and conservation/forest/recreation (27%).
- For the lake's catchment area within the ACT, urban lands account for 20 per cent of the catchment, rural 53 per cent, and conservation/forest/recreation 27 per cent.
- For the sub-catchment areas immediately surrounding the lake, urban areas account for around 44 per cent of the land area, with some 53 per cent conservation/forest/recreation (mostly recreation), and only 3 per cent rural lands.
- The high proportion of adjacent urban land places significant pressure on the water quality of Lake Burley Griffin. This impact is likely to increase in the future with the growth in urban areas, both in the ACT and NSW.
- The management of pollutants from both urban and rural lands needs to be improved to protect the aquatic health of Lake Burley Griffin.

**Land development**

- Lake Burley Griffin's catchment and foreshores have seen significant developments in the last decade.
- The limitations of current monitoring programs mean it is not possible to determine the impact of recent urban developments on Lake Burley Griffin.
- However, it is likely that new urban and other developments are impacting on the lake's water quality with increased runoff of pollutants during rainfall events. It is also highly likely that significant impacts have occurred during the construction phases of development.

**Lake inflows and outflows 2010 to 2021**

- Annual inflows to Lake Burley Griffin ranged from approximately 13,000 megalitres in 2019 to more than 472,000 megalitres in 2021.
- The Molonglo River contributed more than 80 per cent of the annual inflows for all but two years from 2010 to 2021.
- During dry years, the proportion of the lake's total inflows from Sullivans Creek and the Queanbeyan Sewage Treatment Plant (QSTP) increase notably. Sullivans Creek accounted for 18 per cent of the lake's annual inflows in 2018, and the QSTP accounted for more than one fifth (22%) in 2019. These increased proportional inflows mean that urban areas and treated sewage discharges contribute greater proportions of the pollutants entering the lake during dry periods.
- The QSTP can be the only substantial inflow into Lake Burley Griffin during drought periods, discharging a minimum of 3.5 megalitres per day. Whilst this additional inflow has become particularly important since the flows in the Queanbeyan and Molonglo Rivers were reduced by the construction of Googong Dam, it introduces higher nutrient concentrations to the lake in dry periods, increasing the risk of cyanobacterial blooms.

- There are a range of smaller urban streams and stormwater drains that deliver water and pollutants to the lake but these are not monitored.
- The annual inflows for Lake Burley Griffin are decreased in most years by Googong Dam which withholds water from the Queanbeyan River for drinking water supply.
- Annual water release volumes from Scrivener Dam were equal to, or slightly higher than, the measured inflows into the lake for all but the driest years when water was retained to maintain lake levels or to refill the lake.

**Water quality**

- The quality of water flowing into Lake Burley Griffin via the Molonglo River is degraded prior to entering the ACT.
- The main pressures on the lake's water quality and aquatic health are pollutants entering the Molonglo River from rural lands in NSW, pollutants from Queanbeyan Sewage Treatment Plant discharges, and pollutants from urban runoff, including from the construction of new urban and commercial developments in the lake's catchment.

**Recreational closures 2011–12 to 2020–21**

- Lake Burley Griffin is generally open for around 80 per cent or more of recreational seasons, and for five of the reported recreational seasons, it was open for more than 90 per cent of the time.
- Since 2017–18, the main reason for lake closures has been high concentrations of cyanobacteria. Prior to that it was high concentrations of enterococci.
- Rural and urban runoff from the lake's catchments continue to be the main source of enterococci.

**Cyanobacteria (blue-green algae) concentrations 2010 to May 2021**

- Cyanobacteria concentrations vary seasonally with higher concentrations recorded in late summer and early autumn.
- Over 60 per cent of cyanobacteria samples taken had low concentrations, around 25 per cent had medium concentrations, 6 per cent had high concentrations and 5 per cent had extreme concentrations.
- In the periods 2010 to June 2012, and 2018 to 2021, the cyanobacteria cell counts reached the extreme alert level regularly over the summer/autumn seasons. In the intervening period from July 2012 until 2018, there was only one time where the cyanobacteria cell counts reached extreme alert levels.
- There does not appear to be a link between the volume of inflows to the lake and cyanobacteria, with some wet years displaying similar extreme concentrations to dry years.

- Recent research suggests that the key driver of cyanobacterial blooms in the lake may be the release of nutrients that are stored in lake sediments. However, knowledge is limited by the lack of water column data available for Lake Burley Griffin.
- Extreme cyanobacteria concentrations may be increasing in the lake.
- With climate change and increasing urbanisation, cyanobacterial blooms are likely to occur with increasing frequency unless interventions are undertaken to improve the quality of water entering the lake.
- The Canberra community has an important role in preventing algal blooms in Lake Burley Griffin (and the other urban lakes), particularly in preventing large amounts of organic matter from entering the lake.

**Nutrients 2011 to April 2021**

- Around 34 per cent of sampled phosphorus concentrations exceeded guidelines.
- For nitrogen concentrations, around 16 per cent of samples in the East Basin, and 50 per cent of samples in the west of the lake (near Scrivener Dam), exceeded guidelines.
- The greater number of samples exceeding nitrogen guidelines in the west of the lake is likely because of additional nitrogen loads from urban inflows such as Sullivans Creek.
- There are regular occurrences of very high nutrient concentrations in the lake.
- From 2011 to 2019, there was a steady decline in the concentrations of nutrients in the surface waters of the lake. This meant that concentrations were approaching levels at which cyanobacterial blooms could have become phosphorus limited. However, nutrient concentrations notably increased again in 2020 and 2021.
- The reasons for the changes in nutrient concentrations are not clear with decreases occurring across both wet and dry periods.
- The main sources of nutrients to Lake Burley Griffin are rural and urban runoff, and the QSTP. However, the relative contribution of these sources is dependent on the total volume of inflows to the lake.
- Although most nutrients enter the lake via the Molonglo River, inflows from urban areas remain significant sources.
- The QSTP is estimated to contribute approximately 30 per cent of the nutrients to Lake Burley Griffin and has been suggested to be a key driver of lake water quality, including blue-green algal blooms and associated lake closures.
- The QSTP is in the process of being replaced, with a new modern plant scheduled for completion in 2024. It is imperative that the new plant reduce pollutant loads to offset the increasing volume of treated sewage expected from population growth.
- The lake's sediments are also a source of nutrients, and are thought to be significantly increasing bioavailable nutrient concentrations and causing cyanobacterial blooms in the lake.
- Recent research suggests that there is an increasing contribution of nutrients from the lake's urban catchments. A significant portion of the nutrients in urban runoff was found to be in dissolved form which is immediately available to support algal growth leading to greater risk of cyanobacterial blooms.

**Turbidity 2010 to April 2021**

- In the lake's East Basin, only 5 per cent of turbidity samples were outside the acceptable range (less than 40 NTU) with few instances of high turbidity corresponding to very high rainfall events.
- In West Lake, nearly 15 per cent of turbidity samples were outside the acceptable range (less than 20 NTU), most frequently in wetter years. Despite this, turbidity levels are generally lower than for the East Basin.
- Annual average turbidity results show that the expected east to west improvement in turbidity is occurring. However, monitoring also reveal periods where this is not being achieved, particularly during runoff events associated with high rainfall.
- The influence of wetter years on turbidity levels in Lake Burley Griffin shows that rural and urban runoff are the main causes of high turbidity.

**Other water quality parameters 2010 to April 2021**

- Dissolved oxygen pH and conductivity (a measure of salt concentration) were found to be within the acceptable range to support aquatic ecosystems, with very few occasions where samples exceeded guideline levels.

**Maintaining downstream water quality 2010 to April 2021**

- Lake Burley Griffin was found to be effectively mitigating some pollutants and protecting the waters downstream of the lake.
- Phosphorus concentrations in the Molonglo River were similar upstream and downstream of the lake despite the urban catchment inflows such as Sullivans Creek. This suggests that the lake is trapping the additional phosphorus from the urban runoff.
- Nitrogen is particularly well mitigated by Lake Burley Griffin with concentrations lower downstream of the lake compared to upstream.
- With the exception of 2020, turbidity concentrations recorded downstream of Lake Burley Griffin were similar to the levels found upstream in the Molonglo River, and for the Sullivans Creek inflows. This shows that the lake is generally mitigating the potential effects of turbidity from the urbanised inflows.
- In 2020, the turbidity recorded in the Molonglo River downstream of Lake Burley Griffin was markedly higher than that recorded upstream of the lake, demonstrating that urban inflows can have an adverse impact on water quality.

**Biodiversity and ecosystem health**

- Although it is considered that the aquatic ecosystems of Lake Burley Griffin have not changed markedly over the past 30 years, there are limited data available to determine any trends in the broader biodiversity and ecological values of the lake.
- The loss of aquatic macrophytes that were prevalent in the East Basin, between Springbank

Island and the Acton Foreshore in the 1980s has perhaps been the most significant change to Lake Burley Griffin.

- The loss of macrophytes suggest that the lake is now dominated by phytoplankton rather than macrophytes. The reasons for this are unclear but are likely caused by a combination of increased nutrients and turbidity, hydrological changes, poor maintenance and management, and possibly partly attributable to high numbers of carp which are known to adversely affect macrophyte growth.
- Extreme cyanobacterial concentrations have increased over the past 10 years and this is likely to continue given the current nutrient concentrations in the surface waters.
- Regular fish stocking has seen around 138,000 Murray Cod and 142,000 Golden Perch introduced to the lake from 2011–12 to 2020–21. This accounts for some 45 per cent of the Murray Cod stocked to the ACT's urban waters, and nearly 40 per cent of the Golden Perch stocked.
- The water quality and ecosystem health of the lake are sufficient for the survival of stocked native fish, with no evidence of high mortality rates or fish kill events.
- Lake Burley Griffin supports self-sustaining populations of European Carp and Redfin Perch, both introduced species that have negative effects on water quality and other fish species.
- Lake Burley Griffin provides valuable habitat for a variety of water dependent and terrestrial species including bird habitat at Jerrabomberra Wetlands used by migratory waterbird species, and habitat on the foreshores for endangered plant and animal species including Button Wrinklewort and Striped Legless Lizard.

## Lake Burley Griffin key actions

That the ACT Government and the National Capital Authority:

**Key Action 6.1:** Modify the EPA discharge licence for the new Queanbeyan Sewage Treatment Plant to ensure a decrease in discharged pollutants including nutrients (ACT Government only).

**Key Action 6.2:** Undertake research to determine factors driving increased algal blooms in Lake Burley Griffin, including nutrient release from lake sediments and organic matter loads.

**Key Action 6.3:** Analyse the nutrient sources for Lake Burley Griffin, including estimates of contributions from urban and rural catchments, and the proposed replacement Queanbeyan Sewage Treatment Plant. Analysis should include estimates for periods of high and low lake inflows, and for both dissolved and particulate forms. Suspended solids sources should also be assessed.

**Key Action 6.4:** Develop more appropriate phosphorus targets for Lake Burley Griffin, in conjunction with targets for the inflowing streams as part of a broader strategy to reduce the incidence of cyanobacterial blooms.

**Key Action 6.5:** Undertake the restoration of macrophytes in areas of Lake Burley Griffin where they were once prevalent, including areas of East Basin, Lotus bay, Orana Bay, and at Weston Park East Beach.[75] This work should include:

- an assessment of the loss of macrophytes since the 1980s
- identifying priority areas for macrophyte restoration.

**Key Action 6.6:** Develop and implement strategies and programs to reduce the amount of organic matter entering Lake Burley Griffin including leaf litter and other organic matter from urban areas. Particular focus should be given to community actions and current ACT Government street sweeping practices.[76]

**Key Action 6.7:** Monitor the effectiveness and compliance of water pollution control structures for new developments in the Lake Burley Griffin catchment, including during the construction phase, to reduce stormwater impacts on the lake.[77]

75. A similar recommendation was put forward in the 2012 State of Lake Burley Griffin report (Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. ACT Government, Canberra).

76. A similar recommendation regarding street sweeping was put forward in the 2012 State of Lake Burley Griffin report (Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. ACT Government, Canberra).

77. Improved monitoring of developments was listed as a priority action in the Lake Burley Griffin Task Force, 2012, *Lake Burley Griffin Action Plan: A Healthier, Better Functioning Lake by 2030*, ACT Government, Canberra.

### 6.1.2 Pressures on the aquatic health of Lake Burley Griffin

This section discusses pressures that are specific to Lake Burley Griffin. For general water quality and aquatic health pressures see **5.1 Impacts on urban lakes and waterways**, and **5.2 Monitoring water quality and pollutants**.

## Sewage treatment discharges

**Queanbeyan Sewage Treatment Plant**

The Molonglo River upstream of Lake Burley Griffin receives treated discharges from the Queanbeyan Sewage Treatment Plant (QSTP) under an Environmental Authorisation issued by the ACT Environment Protection Authority. Consequently, discharges from the QSTP also flow into Lake Burley Griffin via the Molonglo River. The current sewage treatment plant, built in 1935, is located in the ACT on the banks of the Molonglo River near Oaks Estate. It has been upgraded over time. The most significant improvements, made in the 1980s, greatly reduced the loads of pollutants, faecal matter and nutrients being discharged to the river. General upgrades since then included adjustments to the treatment process in 2009. However, the historic legacy of past discharges is still evident in the sediments of Lake Burley Griffin.[78]

Despite the improvements in sewage treatment, the current QSTP discharges continue to introduce high pollutants loads to Lake Burley Griffin. However, the contribution that the QSTP makes to the total pollutant loads entering the lake depends on the volume of inflows to Lake Burley Griffin. During low flow periods, discharges from the QSTP can account for a significant proportion of the lake's inflow, and consequently the pollutant loads entering the lake (see later sections **6.1.3** and **6.1.4** on Lake Burley Griffin hydrology and nutrients). During average and higher inflow periods, treated effluent discharges from the QSTP are regarded as having a much lower impact compared to diffuse sources which have higher levels of pollutants. It should be noted that this only relates to monitored pollutants. Sewage treatment plants can also discharge a range of non-monitored chemicals, including endocrine disrupting compounds, and pollutants such as microplastics that can have significant impacts on aquatic and human health.

Sewage overflows caused by damaged infrastructure, heavy rains or flood events are an occasional concern. The discharge of untreated or partially treated effluent can introduce many harmful pollutants to waterways, including high levels of faecal bacteria. It can take several weeks for high pollutant levels to disperse. However, incidents of partially treated sewage being released from the QSTP into the Molonglo River because of system failures and heavy rainfall are rare and pollutant contributions from such events are minor. This is particularly the case when compared to the large loads of pollutants already in the Molonglo River and Canberra's urban runoff during extreme rainfall or flood conditions.[79]

78. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.
79. Ibid.

Improving quality of discharges from the QSTP is vital for the health of the Molonglo River and Lake Burley Griffin. The QSTP is in the process of being replaced, with a new modern plant scheduled for completion in 2024. For more information on the new plant and potential impacts on the Canberra's urban waters see **Chapter 12 Urban development and the ACT's lakes and waterways**. Queanbeyan's population is growing and so the volume of treated sewage will also increase in the future. However, the growth in discharge volume may be offset by improvements in the removal of pollutants.

**Other sewage treatment discharges**

Effluent from Canberra's eastern residential and industrial areas is treated at the Fyshwick Sewage Treatment Plant, which provides sewer network capacity during wet weather events. Treated residuals are transferred to the Molonglo Outfall Sewer Tunnel for further treatment at the Lower Molonglo Water Quality Control Centre on the lower Molonglo River. Consequently, wastewater from eastern Canberra is currently diverted around Lake Burley Griffin. Despite this, there remains potential for treated effluent to be discharged to the lake during severely wet periods or in the case of infrastructure failure.

Other sewage concerns for the Molonglo River and Lake Burley Griffin include the treatment plant at Captains Flat (NSW) in the upper reaches of the Molonglo River, and the presence of Onsite Sewage Management Systems (OSSMs) in the Queanbeyan-Palerang area (including the upper Molonglo River catchment and the Googong Reservoir catchment). OSSMs, such as septic tanks or aerated water treatment system and effluent disposal areas, represent a risk to water quality when system failures contaminate waterways. Such failures can be a source of serious environmental and public health concern. Currently there are approximately 5700 OSSMs within the Queanbeyan-Palerang area.[80]

**Land development**

With population growth significantly increasing demand for urban and commercial developments in the ACT, the foreshores of Lake Burley Griffin have seen significant developments in the last decade. This includes the completion of the Kingston Foreshore development in 2013 and the current Acton Waterfront project which, aside from the addition of recreation areas on the lake foreshore and a 550m boardwalk, has resulted in the infill of some 30,000 square metres of lake area.[81] The project is also anticipated to see the construction of a residential and mixed-use development area (subject to community consultation and approvals).

There has also been increased urban development in Lake Burley Griffin's sub-catchments including Sullivans Creek and the Lower Queanbeyan River.

With the limitations of current monitoring programs (see **11.8 Effectiveness of monitoring, evaluation and reporting processes for urban waters**), it is not possible to determine the impact of recent urban

80. Queanbeyan-Palerang Regional Council, 2018, *QPRC On-Site Sewage Management Policy*, Queanbeyan-Palerang Regional Council, Queanbeyan.

81. City Renewal Authority: https://www.act.gov.au/cityrenewal/places/Acton-Waterfront/acton-boardwalk-extension. ACT Government, Canberra.

developments on Lake Burley Griffin. However, it is likely that such developments impact on water quality in the lake with increased runoff of pollutants during rainfall events, and especially from the high levels of sediment and other pollutants entering the lake during the construction phase.

Improved monitoring of developments was listed as a priority action in the *Lake Burley Griffin Action Plan: A Healthier, Better Functioning Lake by 2030*.[82] Specifically:

- continue to monitor the effectiveness and compliance of wetlands and pollution control structures for sediment control during construction phases of developments and subsequently to inform maintenance and effective functioning
- monitor existing newer sites such as at Kingston Foreshore and in the Sullivans Creek catchment to assess impact on stormwater management system.

The inability to assess development impacts on water quality for this Investigation demonstrates that these priority actions have not been addressed.

**Legacy of metal pollution**

High concentrations of heavy metals such as mercury, lead, chromium, cadmium, zinc and arsenic can be toxic to aquatic species and impact on human health. Mining activity in the Captains Flat area (NSW) from 1939 to 1962 has left a legacy of heavy metal pollution in Lake Burley Griffin.[83, 84] Despite mining activity ending before the filling of the lake, heavy metals were deposited into it because of the runoff from abandoned mine sites and tailing dumps. This runoff discharged toxic drainage water into the Captains Flat creek which flowed into the Molonglo River and Lake Burley Griffin.

Concern over the level of heavy metals led to pollution abatement works by the Commonwealth and NSW governments in the mid-1970s. These works were effective in reducing mine site runoff and controlling the detectable impacts on Lake Burley Griffin. Monitoring from 1974 to 1978 confirmed a reduction in metal contamination entering the lake. More recently, assessments of Lake Burley Griffin sediment samples collected in 2018 found that the highest detected levels of mercury corresponded to sediment from the early 1960s.[85] Concentrations in more recently deposited sediments were lower, suggesting that mine rehabilitation activities had reduced the contribution of mercury to the lake. Concentrations of mercury in the sediments were noted to be below the thresholds of concern.

Although high levels of some metals remain in Lake Burley Griffin, these are generally restricted to the sediments with ongoing sediment deposits overlaying the heavy metals and keeping it in place. However, any processes that disturb the overlying sediment may expose the heavy metals and increase the risk of mobilising them.

82. Lake Burley Griffin Task Force, 2012. *Lake Burley Griffin Action Plan: A Healthier, Better Functioning Lake by 2030*. ACT Government, Canberra.

83. National Capital Authority, 2011. *Lake Burley Griffin Water Quality Management Plan 2011*. National Capital Authority, Canberra.

84. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.

85. Stinton, D., et al., 2020. *The spatial legacy of Australian mercury contamination in the sediment of the Molonglo River*. Elementa: Science of the Anthropocene 8:44.

Heavy metal concentrations in the lake are currently not considered to impact on aquatic or human health. The 2012 Investigation into the state of Lake Burley Griffin found that most heavy metal concentrations were within the range recommended for lake sediments by the ANZECC Guidelines, with the exception of zinc and lead.[86] The Investigation concluded that there was little potential for these to be mobilised and taken up by organisms because of reactions associated with the high concentrations of iron in the lake sediments. In addition, analysis of trace metal concentrations in fish caught from the lake have been found to be extremely low or below detection values specified by the Australian National Food Authority.[87]

*Urban development around Lake Burley Griffin at night. Source: Creative Commons*

86. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.

87. National Capital Authority, 2011. *Lake Burley Griffin Water Quality Management Plan 2011*. National Capital Authority, Canberra.

### 6.1.3 Data trends for Lake Burley Griffin

## Lake Burley Griffin catchment and hydrology

**Catchment**

Lake Burley Griffin drains a total catchment area of approximately 1,866 $kms^2$, comprising a mix of urban (5%), rural (68%) and conservation/forest/recreation (27%) land uses (Figure 6.1a, Figure 6.2).

The proportion of land uses differs significantly when only the sub-catchments immediately surrounding the lake are considered (i.e., the Lake Burley Griffin and Sullivans Creek sub-catchments). For these surrounding sub-catchments, urban areas account for around 44 per cent of the land, with 53 per cent being conservation/forest/recreation (mostly recreation), and only 3 per cent rural lands (Figure 6.1 b). Given that urban areas contribute a disproportionately large share of the pollution entering the lake, this high proportion of urban land places significant pressure on the water quality of Lake Burley Griffin. Such impacts are likely to increase in the future with the growth in urban areas in the lake catchment, both in the ACT and NSW. Currently, the largest urban sub-catchments for Lake Burley Griffin are those of Sullivans Creek and the Lower Queanbeyan River.

For the lake's catchment area within the ACT (the Lake Burley Griffin, Sullivans Creek, Woolshed Creek, Jerrabomberra Creek, Lower Molonglo and Molonglo sub-catchments), urban lands account for 20 per cent of the catchment, rural 53 per cent and conservation/forest/recreation 27 per cent (Figure 6.1c).[88] With these ratios of land use within the ACT catchment, both urban and rural lands need to be managed to protect the aquatic health of Lake Burley Griffin.

88. Note: whilst the great majority of the Jerrabomberra Creek, Lower Molonglo and Molonglo sub-catchments are in the ACT, some of these catchments are in NSW.

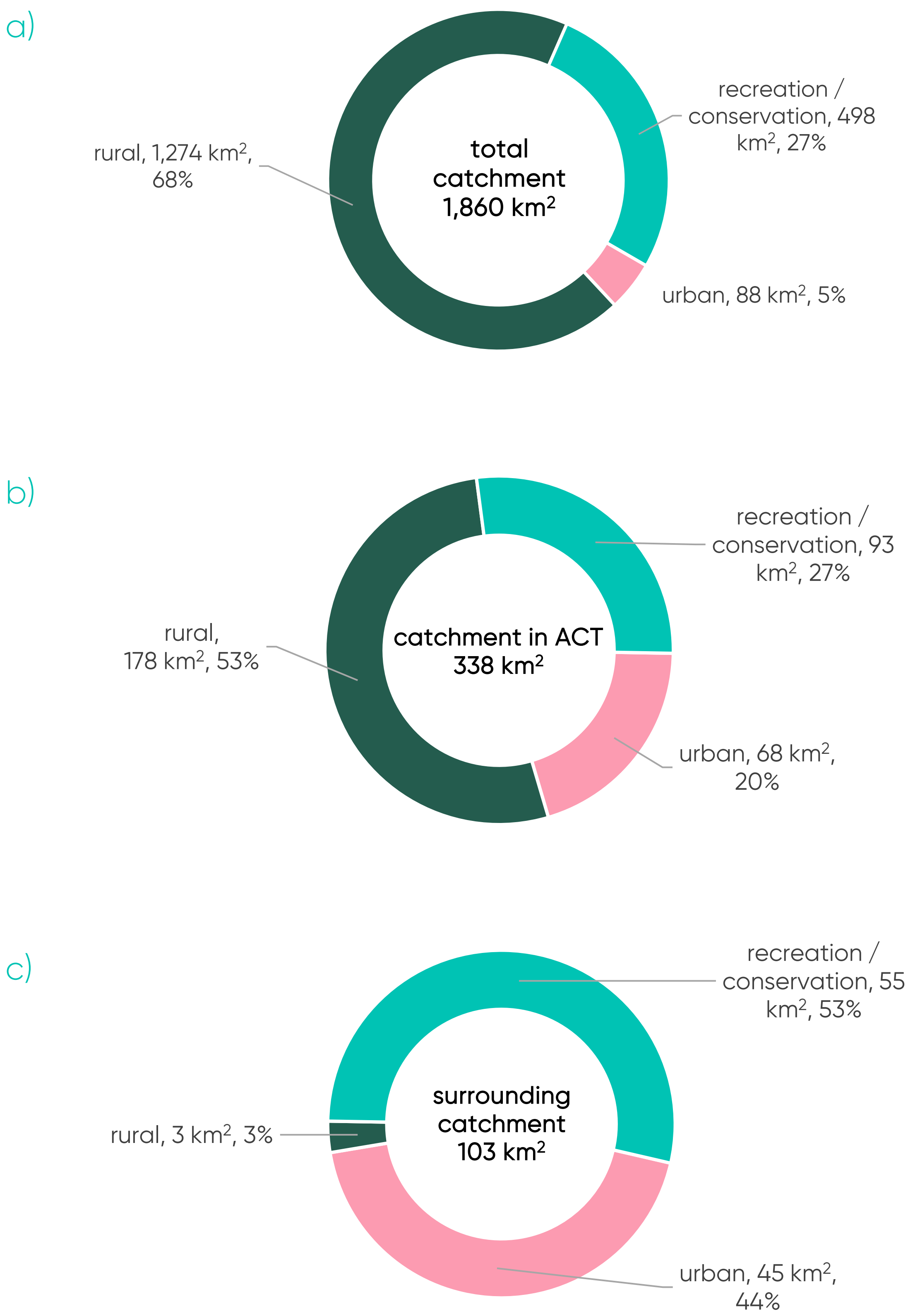


**Figure 6.1.** Land uses in the Lake Burley Griffin catchment for: a) the total catchment, b) sub-catchments within the ACT, and c) sub-catchments surrounding the lake.

**Data sourced from:** University of Canberra Centre for Applied Water Science, ACT and NSW Government data.

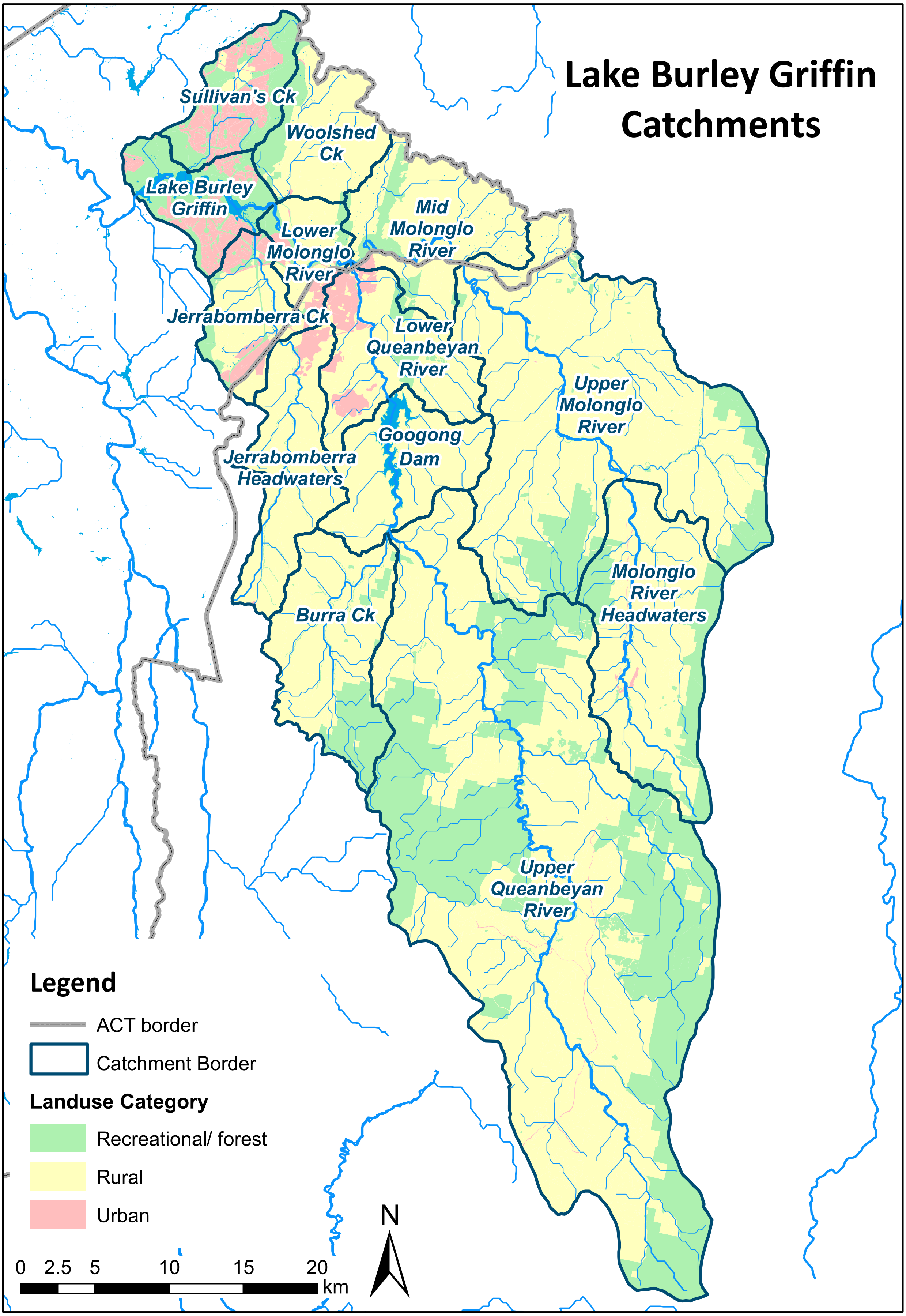


**Figure 6.2.** Lake Burley Griffin catchment and land use.

**Source:** University of Canberra Centre for Applied Water Science. Data sourced from ACT and NSW Governments.

### Hydrology

Lake Burley Griffin has a surface area of 6.64 square kilometres, an average depth of four metres and a maximum depth of almost 18 metres near Scrivener Dam. The lake has a capacity of approximately 33,700 megalitres. Flows through Lake Burley Griffin and the Molonglo River downstream are regulated by Scrivener Dam. The lake is operated as a landscape feature and is maintained at a constant level, with release volumes at Scrivener Dam reflecting inflows at its eastern end.

### Inflows to Lake Burley Griffin

#### Sources of inflows

The main natural (water from rainfall in the catchment) inflows to Lake Burley Griffin include the Molonglo River (which receives water from the Queanbeyan River and Woolshed Creek), Jerrabomberra Creek, and Sullivans Creek (Figure 6.3). There is also a range of smaller urban streams and stormwater drains that deliver water to the lake but these are not included in this report because long-term flow records are not available. The smaller lake inflows include:

- streams and drains that flow through Yarralumla into Yarramundi Reach and into West Lake though Lotus Bay
- drains that flow through Telopea Park and Bowen Park and enter East Basin
- drains that flow through Kingston Foreshore and enter East Basin
- a drain through Campbell flows into the eastern end of Central Basin, and
- drains that flow through the central city area.

In addition to natural inflows, Lake Burley Griffin receives discharges from the Queanbeyan Sewage Treatment Plant (QSTP). These can contribute a significant proportion of the lake's inflows during drought conditions.

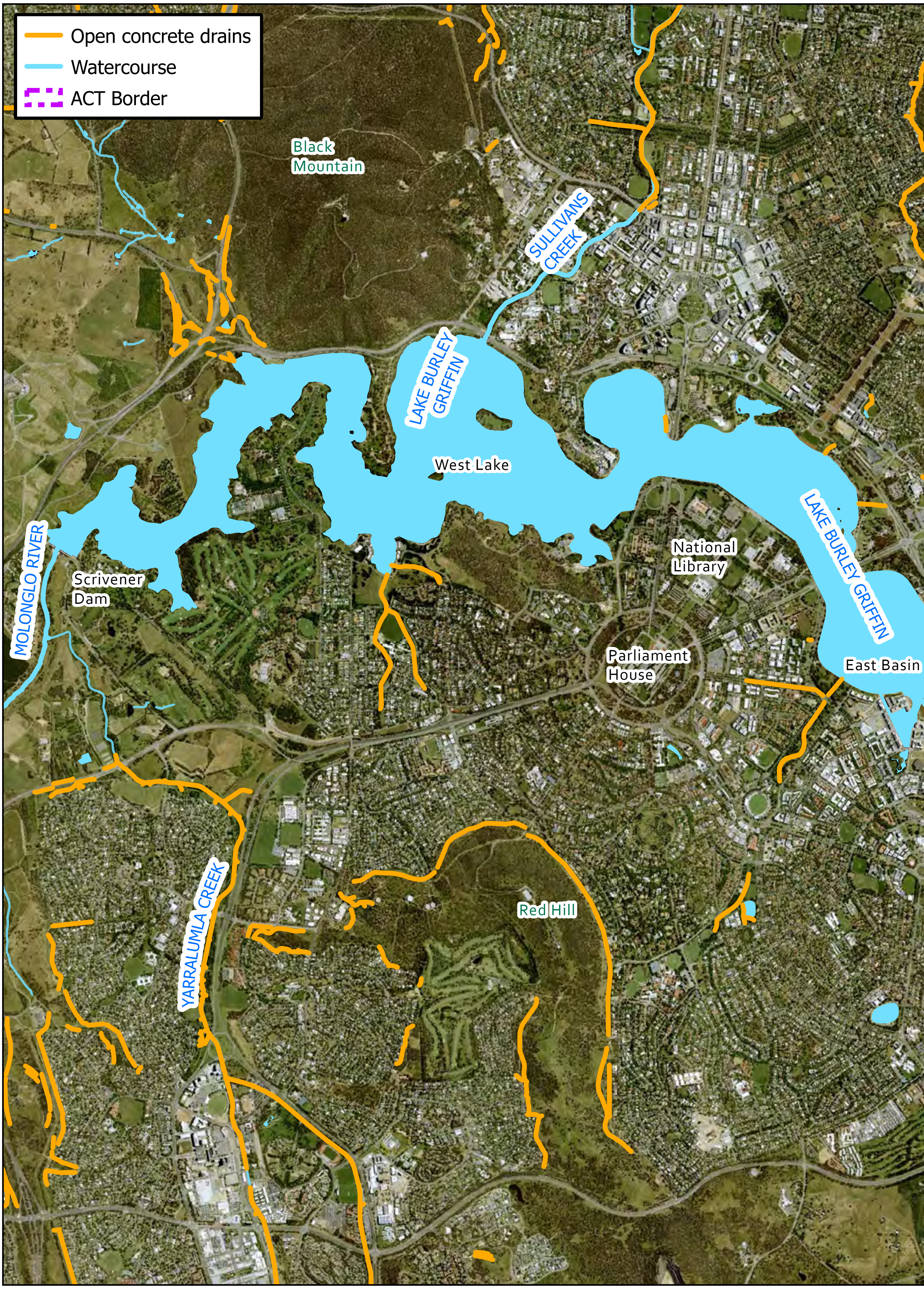


**Figure 6.3.** Lake Burley Griffin and related waterways including main inflows

**Data sourced from:** ACT Government


Mount Ainslie
WOOLSHED CREEK
MOLONGLO RIVER
Jerrabomberra Wetlands Nature Reserve
JERRABOMBERRA CREEK
MOLONGLO RIVER
Queanbeyan Sewage Treatment Plant
N
Kilometers
0
1
2
OCSE

**Annual inflow volumes**

From 2010 to 2021, the annual inflows to Lake Burley Griffin ranged from approximately 13,000 megalitres in 2019 to more than 472,000 megalitres in 2021 (Figure 6.4). The Molonglo River contributed more than 80 per cent of the annual inflows for all but two years from 2010 to 2021 (Figure 6.5). During dry years, the proportion of inflows from Sullivans Creek and the QSTP increases notably because of the reduced Molonglo River flows. Sullivans Creek accounted for 18 per cent of the lake's total annual inflows in 2018 and 16 per cent 2019; the QSTP made up 13 per cent of inflows in 2018, and more than one-fifth (22%) in 2019. Elevated proportional inflows from Sullivans Creek and the QSTP have consequences for water quality in Lake Burley Griffin, including relatively higher concentrations of pollutants from urban areas and higher concentrations of nutrients from the treated discharges.

Even though discharges from the QSTP may not be the main annual inflow to Lake Burley Griffin, in terms of daily flows the treatment plant can at times be the dominant water source for the lake. This is because it generally discharges a minimum of 3.5 megalitres per day[89] and an annual average daily flow of between seven and 10 megalitres a day from 2010 to 2020. During drought periods, the discharge from the QSTP can be the only substantial inflow into Lake Burley Griffin (via the Molonglo River). Whilst this additional inflow has become particularly important since the flows in the Queanbeyan and Molonglo rivers were reduced by the construction of Googong Dam, it does introduce higher nutrient levels to the lake in dry periods, increasing the risk of cyanobacterial blooms.

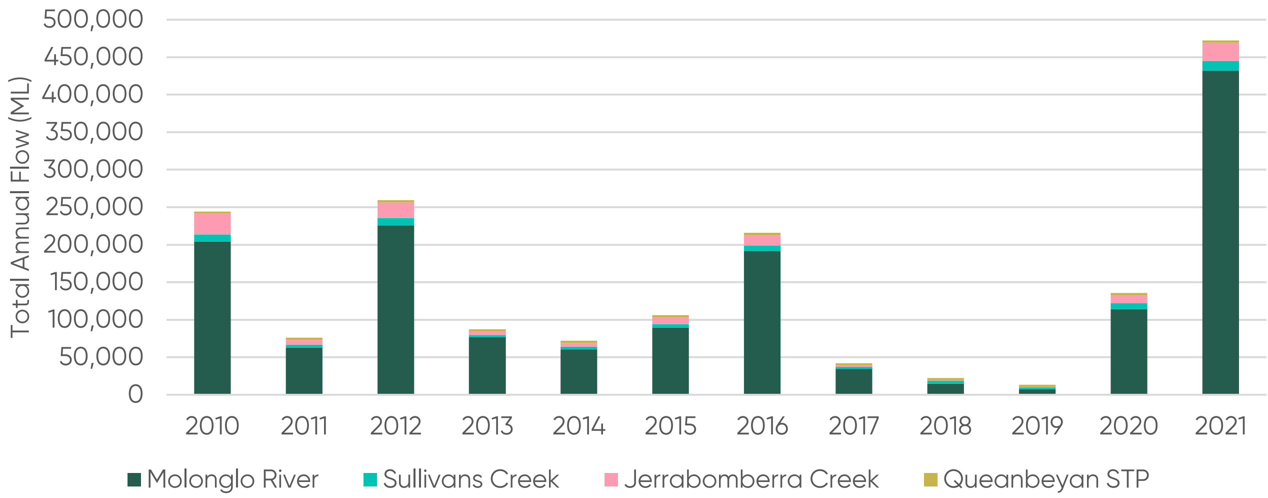


**Figure 6.4.** Annual inflows to Lake Burley Griffin, 2010 to 2021.

**Data sourced from:** Environment, Planning and Sustainable Development Directorate.

**Note:** Queanbeyan Sewage Treatment Plant discharge data was not available for 2021. Figure presented for 2021 is the average discharge for 2010 to 2020.

89. Queanbeyan-Palerang Regional Council, October 2020. *Draft Queanbeyan Sewage Treatment Plant Upgrade Environmental Impact Statement*. Queanbeyan-Palerang Regional Council, Queanbeyan.

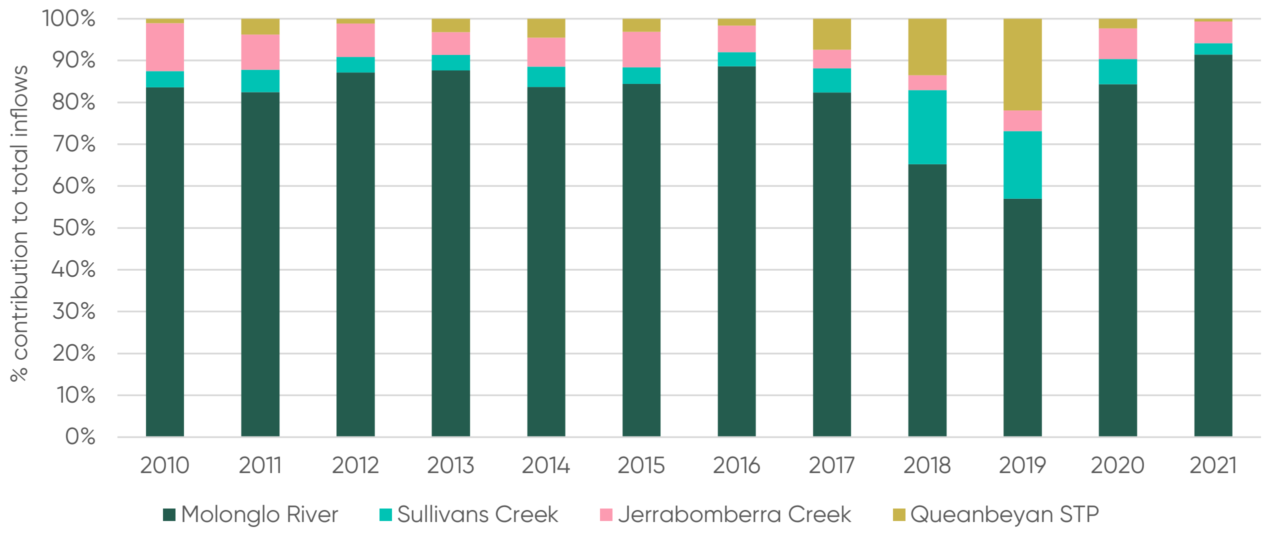


**Figure 6.5.** Annual proportional contribution of inflows to Lake Burley Griffin, 2010 to 2021.

**Data sourced from:** Environment, Planning and Sustainable Development Directorate.

**Note:** Queanbeyan Sewage Treatment Plant discharge data was not available for 2021. Figure presented for 2021 is the average discharge for 2010 to 2020.

The inflows from the small urban streams and stormwater drains that deliver water to the lake are not routinely measured. However, as part of the Healthy Waterways project, Telopea Creek in Bowen Park was monitored, including measurements of flow into the lake. The annual flow into the lake from Telopea Creek in 2019 was 22 megalitres, which is negligible compared with approximately 13,400 megalitres from the three main tributaries. This suggests that even the combined flows from the non-gauged stormwater network is unlikely to make a substantial contribution to the lake inflows.

#### Impacts of Googong Dam on inflows to Lake Burley Griffin

The annual inflows for Lake Burley Griffin are reduced by Googong Dam which impounds water in the Queanbeyan River for community water supply. Reduced inflows to the lake can cause reductions in both the water level and flow rates, impacting on aquatic health, water quality, and increasing the occurrence of algal blooms.

There are environmental flow guidelines that specify a minimum volume of water released from Googong Dam (10 megalitres per day) to maintain aquatic health in the Queanbeyan River.[90] Any additional water releases from Googong Dam are dependent on the amount of water impounded in the reservoir. For example, inflows after rainfall may be retained in Googong Dam to replenish water levels and increase the volume available for water supply.

Over the 2010 to 2021 period, some 160,000 megalitres of Googong Dam inflows were impounded for community water supply (Figure 6.6). This represents around 16 per cent of total inflows to the dam with this water lost to the Queanbeyan River downstream of the dam, and consequently the Molonglo River and Lake Burley Griffin. It should be noted that not all of the Googong Dam outflows would reach the Molonglo River and Lake Burley Griffin because of natural losses and water use for rural lands.

90. Water Resources Environmental Flow Guidelines, 2019 (No 2). https://www.legislation.act.gov.au/di/2019-190/.

The biggest differences between the Googong Dam inflows and outflows occur in wet years following drought periods when water is retained to increase storage levels. In 2010 and 2020, around 28 per cent and 75 per cent of the total inflows (around 69,000 megalitres for both years) were retained in the dam. These years also represent the most water lost to Lake burley Griffin with the difference between Googong Dam inflows and outflows representing 28 per cent of the total lake inflows in 2010, and 51 per cent in 2020. Other years where Googong Dam outflows were lower than inflows represented 15 per cent or less of the lake's total inflows.

It is interesting to note that during the severe drought years from 2017 to 2019, dam outflows were higher than inflows because of the environmental flow releases, although the volume of inflows were very low. Without this flow requirement, there would be periods with no outflows from the dam during times of severe drought.

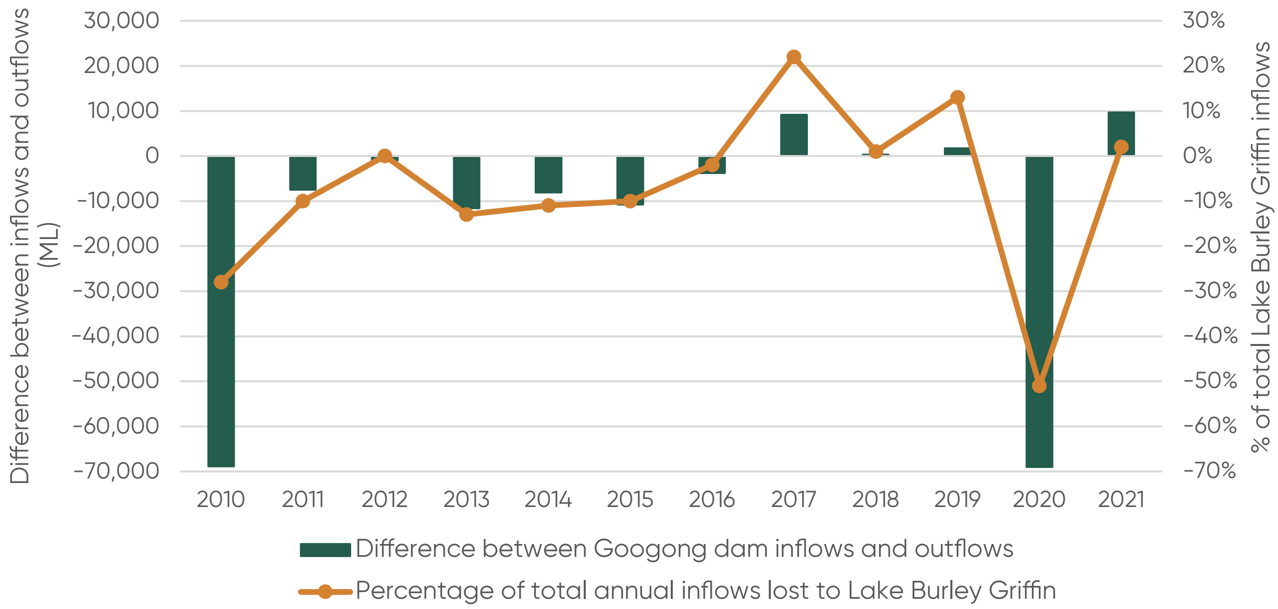


**Figure 6.6.** Difference between Googong Dam inflows and outflows compared to total inflows for Lake Burley Griffin, 2010 to 2021.

**Data sourced from:** Icon Water and the Environment, Planning and Sustainable Development Directorate.

The Googong Dam diversion findings for this Investigation are supported by those of the 2012 Investigation into the state of Lake Burley Griffin which provided estimates of how much water was being diverted from the lake since the construction of Googong Dam.[91] This was found to be around 7 per cent of the average annual inflow to the lake for the period 1978 to 2010. That investigation also found that the impact of Googong Dam is more significant during dry periods. For example, as a consequence of the Millennium drought and impacts of the 2003 fires on the Cotter water supply, the diversion of water by Googong Dam was estimated to have increased to 50 per cent of the average annual inflow to the lake for the period 2003 to 2010.

91. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.

### Outflows from Lake Burley Griffin

Maintaining acceptable flows downstream of Lake Burley Griffin is important for the ecosystem health of the Lower Molonglo River and for flows in the Murrumbidgee River. From 2010 to 2021, annual release volumes from Scrivener Dam were equal to, or slightly higher than, the inflows into the lake for all but the driest years (Figure 6.7).[92] During the drought period from 2017 to 2019, Scrivener Dam outflows declined to 90 per cent of the lake inflows in 2017, and continued to fall to just 57 per cent in 2019. This difference between inflows and outflows reflected the need to retain water to maintain lake levels during drought periods or to refill the lake after water levels had dropped, and from lake water losses caused by evaporation.

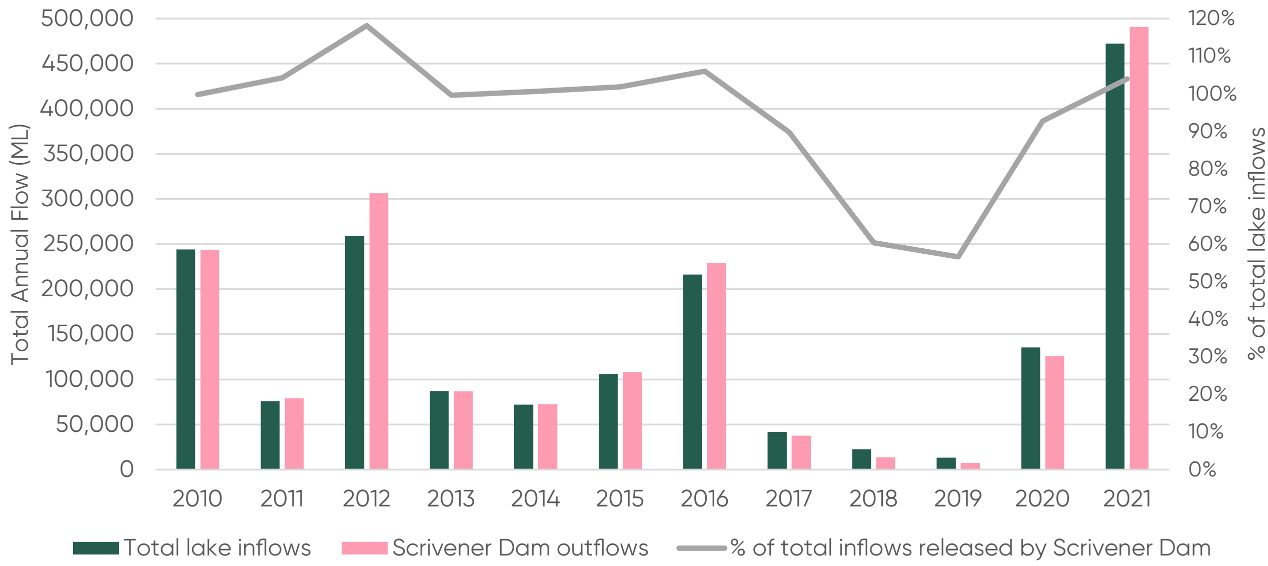


**Figure 6.7.** Comparison of annual inflows and outflows for Lake Burley Griffin, 2010 to 2021.
**Data sourced from:** Inflow data obtained from the Environment, Planning and Sustainable Development Directorate. Scrivener Dam release data obtained from the National Capital Authority.

Although flows downstream of Lake Burley Griffin are considered appropriate for all but drought years, there is concern that inappropriate flow regimes and thermal pollution resulting from the construction and operation of Scrivener Dam are a threat to native fish in the lower Molonglo River.[93]

92. Periods where the lake outflow volume was higher than the total measured inflows are likely caused by additional inflows from non-monitored sources including stormwater and groundwater.

93. Cheetham, E., Norris. R., and Williams, D., undated. *Recommended environmental flow release scheme for the lower Molonglo River reach.* Report prepared by University of Canberra Institute for Applied Ecology for ACT Planning and Land Authority and ACT Procurement Solutions.

### 6.1.4 Water quality in Lake Burley Griffin

*The water flowing into Lake Burley Griffin via the Molonglo River is already degraded. This is because the lake's main inflows have catchments with a range of rural and urban land uses, as well as other pressures such as the Queanbeyan Sewage Treatment Plant, that impact on water quality. With the Molonglo River catchment and its tributaries upstream of Lake Burley Griffin almost entirely in NSW, the quality of water entering the lake is largely dependent on the management and improvement of aquatic health in both the ACT and NSW.*

#### Recreational water quality

Lake Burley Griffin recreational water quality is monitored at 10 sites over the mid-October to mid-April recreational period. The lake is closed to recreational use if either cyanobacteria (blue-green algae) or enterococci (a faecal indicator bacteria) concentrations exceed the levels specified in the ACT recreational water guidelines.[94] Closures prevent community access to Lake Burley Griffin for activities that involve primary contact. Long closure periods have consequences for health and wellbeing, particularly because Canberrans value the lake for summer activities and to provide relief on hot days. Lake Burley Griffin closures also have economic consequences for a range of lake dependent businesses because of the cancellation of lake related activities and reduced patronage from lower visitation rates.

#### Lake Burley Griffin closures

Monitoring results for the period 2011–12 to 2020–21 show that Lake Burley Griffin is generally open around 80 per cent or more of the recreation season and for five of the reported recreational seasons, it was open for more than 90 per cent of the time (Figure 6.8). It was closed most frequently in the summer of 2011–12 and from 2017–18 to 2020–21. The 2020–21 recreation season was one of the worst for closures — the lake was closed for more than 30 per cent of the time. There are no clear trends for Lake Burley Griffin recreational closures.

Since 2017–18, most lake closures have been caused by high concentrations of cyanobacteria. Prior to that, the main reason for closures was high concentrations of enterococci. There are no clear reasons for the differences.

Rural and urban runoff from the lake's catchments continue to be the main source of enterococci. For sewage treatment discharges, previous assessment has found that the release of fully treated sewage effluent from the Queanbeyan Sewage Treatment Plant is not a significant source of faecal contamination in Lake Burley Griffin.[95] The main risk of faecal contamination from sewage treatment discharges comes from overflows of untreated effluent caused by large storm events.

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94. ACT Health, 2014. *ACT Guidelines for Recreational Water Quality*. ACT Government, Canberra.

95. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.

Other potential sources of faecal contamination in Lake Burley Griffin come from damaged sewerage pipes. Leaks can cause faecal material to enter groundwater and nearby stormwater drainage systems, creating a diffuse source of faecal pollution. The extent of this potential issue is unknown. Icon Water manages the sewerage network and has a preventative maintenance program that addresses problematic sewer mains within Canberra.

In the absence of comprehensive information on faecal contamination, it is not possible to accurately determine the main sources of enterococci found in Lake Burley Griffin.

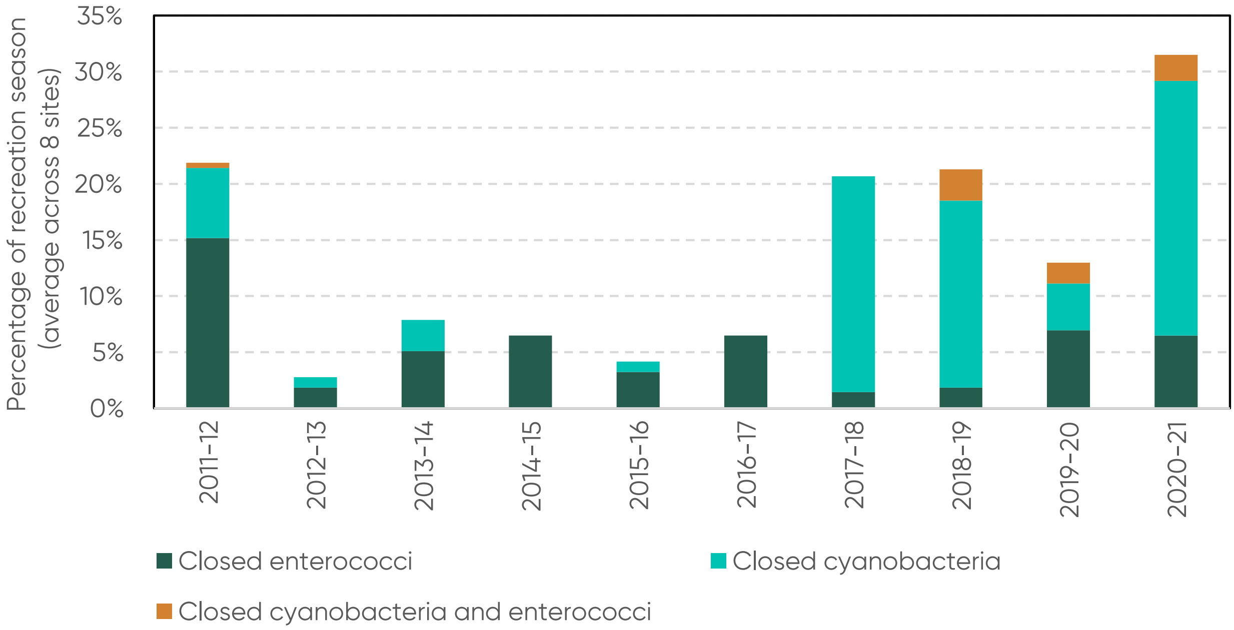



**Figure 6.8.** Proportion of the lake Burley Griffin recreation season closed to recreational activities, 2011–12 to 2020–21.

**Data sourced from:** National Capital Authority.

**Note:** Data show the average closures across eight monitored sites during the recreation season (Mid-October to mid-April).

## Levels of cyanobacteria

Cyanobacteria cell counts in Lake Burley Griffin for the period January 2010 to May 2021 are shown in Figure 6.9. More than 60 per cent of samples taken had low cyanobacteria concentrations, around 25 per cent had medium concentrations, 6 per cent had high concentrations and 5 per cent had extreme concentrations. These concentrations vary seasonally with higher concentrations recorded in late summer and early autumn. Three distinctly different time periods were evident in the data used for this Investigation. In the periods 2010 to June 2012, and 2018 to 2021, the cell counts reached the extreme alert level regularly over the summer/autumn seasons. In the period from July 2012 until 2017, there was only one occurrence where the cyanobacteria cell counts reached extreme alert levels. In this intervening period, the cell counts were substantially lower than the years before or after. There does not appear to be a link between inflows to the lake and cell counts, with the wet years of 2010 to 2012 displaying similar extreme concentrations of cyanobacteria to the drier years from 2017 and 2019 (Figure 6.9).

Extreme cyanobacteria levels occurred in six of the 10 summers from 2012 to 2021, compared with four of the preceding 10 years (estimated from the 2012 Lake Burley Griffin Investigation). This may suggest that the incidence of extreme cyanobacteria concentrations is increasing in Lake Burley Griffin.

The 2012 Lake Burley Griffin Investigation suggested that cyanobacteria and other algal blooms were likely to persist because of conditions such as high summer temperatures, solar radiation, mild wind speeds in late summer and autumn, as well high nutrient concentrations and organic matter loads.[96] This finding has been supported over the past decade, with high to extreme concentrations of cyanobacteria occurring in most years, albeit not always resulting in significant periods of lake closures. The 2012 Investigation also suggested that cyanobacteria blooms were related to dry years, but this has not been evident in the data used in this Investigation which shows blooms occurring in wetter years. It is clear that the causes of cyanobacteria blooms in the lake are complex, requiring more detailed investigations to better understand the key drivers.

It is thought that water temperature is one of the key limiting factors for cyanobacterial blooms in Canberra's urban lakes. With climate change increasing temperatures across the region, blooms in Lake Burley Griffin may continue to increase in the future.

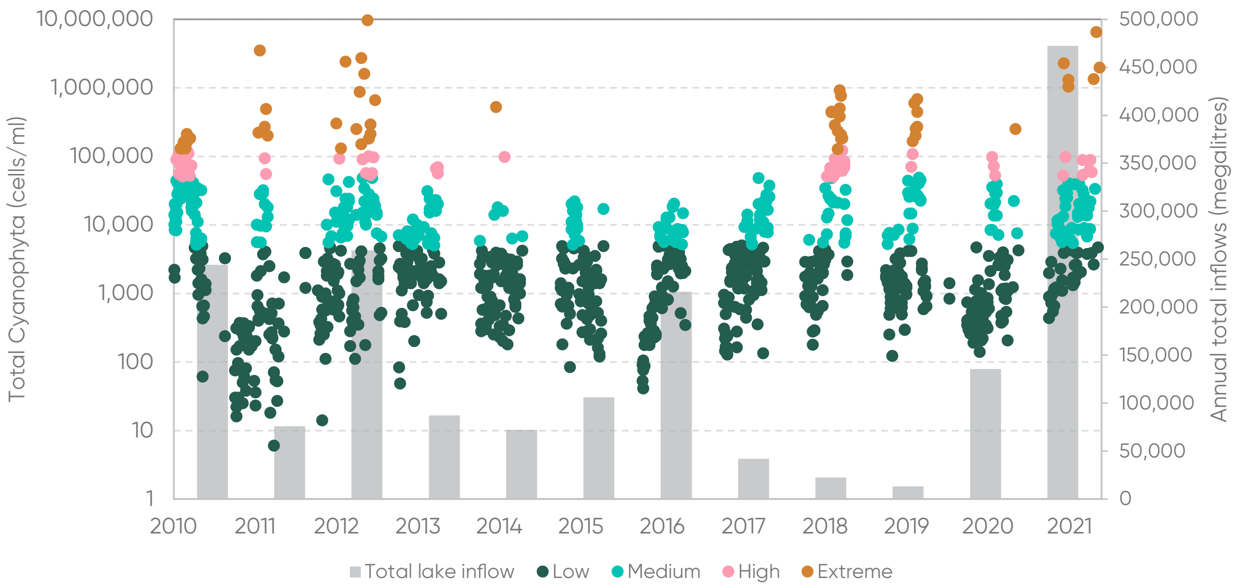



**Figure 6.9.** Cyanobacteria cell counts in Lake Burley Griffin for the period 2010 to May 2021 and estimated annual inflows to the lake (grey bars).

**Data sourced from:** Cyanobacteria data from the National Capital Authority, inflow data from the Environment, Planning and Sustainable Development Directorate.

**Note:** The low to extreme categories indicate cyanobacteria alert levels in the *ACT Guidelines for Recreational Water Quality*. Low = <5,000 algae cells/ml; Medium = ≥5,000 to <50,000 algae cells/ml; High = ≥50,000 to ≤125,000 algae cells/ml; Extreme = ≥125,000 algae cells/ml.

96. Ibid.

Recent research suggests that the key driver of cyanobacterial blooms in the lake may be the release of nutrients that are stored in lake sediments.[97] If this is the case, it is likely that blooms will continue to occur with increasing frequency unless interventions are undertaken to manage the supply of nutrients both to and from the sediments. However, knowledge is limited by the lack of water column data for Lake Burley Griffin.

A comparison of cyanobacteria results between Lake Burley Griffin and Lake Tuggeranong supports the theory that the release of nutrients from internal processes is an important driver of algal blooms in Lake Burley Griffin. The peak concentrations in Lake Tuggeranong occur slightly earlier in the recreational season than in Lake Burley Griffin (see section **6.2.4 Water quality in Lake Tuggeranong**). These differences in seasonal patterns between the two lakes suggest that there are different processes driving the algal blooms.[98] Whilst it is likely that algal blooms in Lake Burley Griffin may be much more internally driven, the predominant driver of algal blooms in Lake Tuggeranong is likely to be the high nutrient concentrations from catchment runoff. It is also evident that there are greater algal concentrations in Lake Tuggeranong in response to periods of high rainfall which deliver large loads of nutrients to the lake.

These differences in algal bloom drivers between the lakes have consequences for the effectiveness of management approaches. To reduce the occurrence of cyanobacterial blooms in the future, management actions will need to address the main drivers of algal blooms specific to each urban lake, rather than utilising a common approach. Although reducing the loads of nutrients entering lakes will be beneficial regardless of the main drivers.

## Prevention of algal blooms

There have been several suggested solutions to address algal bloom issues in Lake Burley Griffin. These are outlined in the 2012 Investigation on Lake Burley Griffin and include: the restoration of macrophyte systems to intercept pollutants; artificial re-aeration devices and mechanical mixers to interrupt lake stratification and reduce nutrient availability; modification of phosphorous cycling by adding chemical compounds that adsorb and remove phosphorus from the water column and prevent cycling from sediments (e.g. Phoslock®); algal farming to remove nutrients; and even the sonic destruction of algae using ultrasonic sound waves to rupture algal cells.[99]

Such interventions are either not feasible, remain untested or have proven to be ineffective. For example, the trial of mixer machines undertaken by the National Capital Authority found no obvious impact from the SolarBee (mixer) units on surrounding water quality.[100] Other approaches to reducing the occurrence and severity of algal blooms include the use of floating wetlands to remove lake nutrients. Any proposed algal bloom interventions need to have comprehensive assessments of their potential effectiveness as well as of the environmental, social and economic impacts.

97. Dyer, F., O'Connell, J., and Ubrihien, R., 2020. *Managing cyanobacteria in Lake Burley Griffin: Data review and recommendations. A report to the National Capital Authority from the Centre for Applied Water Science*. University of Canberra, Canberra, June 2020.

98. Ibid.

99. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.

100. GHD, 2012. *SolarBee water quality data for the period September 2011 – May 2012*. Unpublished report, supplied by the National Capital Authority.

With the many uncertainties around possible algal bloom interventions, it is clear that the most effective approach to preventing the occurrence of blue-green algal blooms is to reduce the levels of nutrients, sediment and organic matter entering Lake Burley Griffin. Such reductions will also help to offset the releases of nutrients from lake sediments and decrease the concentration of nutrients and amount of organic matter stored in lake sediments over time.

Decreasing levels of nutrients and organic matter in Lake burley Griffin can only be achieved by improving the quality of water entering the lake. This requires improving the effectiveness of urban runoff interception and pollutant removal through additions to the current water sensitive urban design infrastructure, as well as improving the performance of such infrastructure. It should be noted that water quality improvements are likely to take many years, particularly for measures to reduce nutrient concentrations.

The community also has an important role in reducing the occurrence of algal blooms by helping to improve the quality of urban stormwater (see section **10.3 The community's role in water management**).

## Nutrients

From 2010 to April 2021, water quality monitoring results for phosphorus concentrations in Lake Burley Griffin showed that around 34 per cent of samples exceeded guidelines (Figure 6.10). Results also showed regular occurrences of very high phosphorus concentrations.

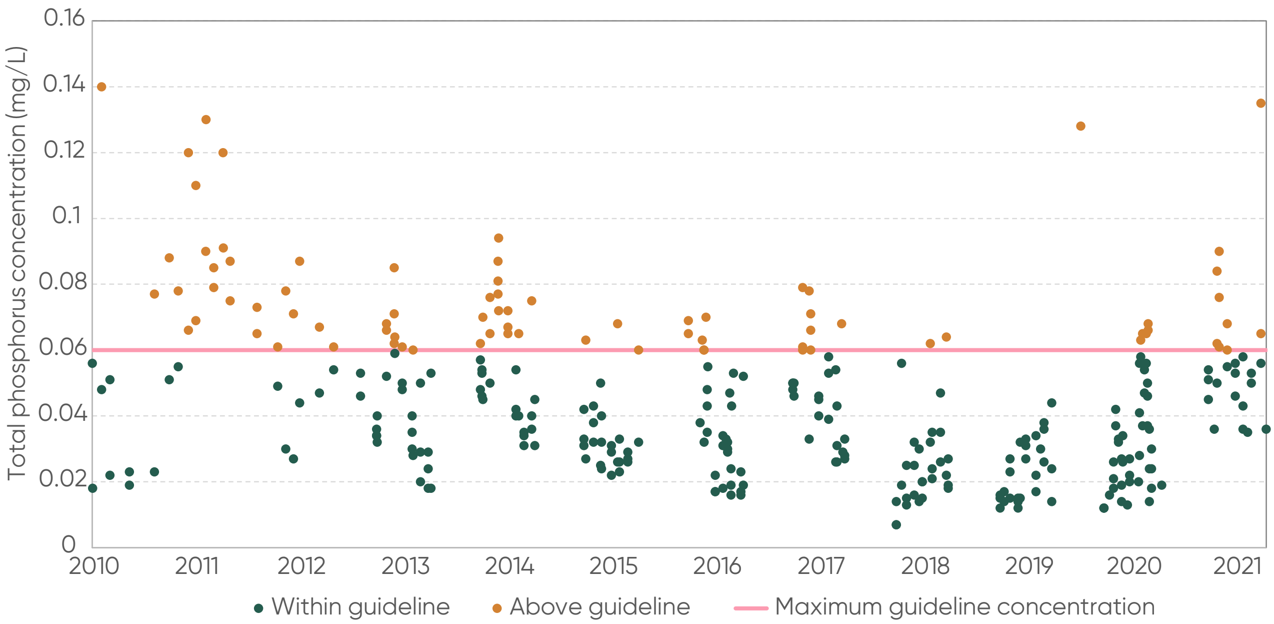



**Figure 6.10.** Total phosphorus concentrations in the surface waters of Lake Burley Griffin, 2010 to April 2021. The pink line shows the maximum acceptable concentration for total phosphorus specified in the Lake Burley Griffin Water Quality Management Plan.

**Data sourced from:** National Capital Authority.

**Note:** Data are from five sites for each calendar year. Data from 2021 conclude at the end of the recreational season (April).

Guideline levels for nitrogen concentrations differ in relation to lake location, with East Basin areas having a higher threshold (1.4 milligrams per litre) compared to the western areas of the lake (1 milligram per litre).[101] The difference in guideline levels is to compensate for the higher loads of nitrogen entering Lake Burley Griffin through the treated discharges from the Queanbeyan Sewage Treatment Plant.

For nitrogen concentrations in the East Basin, around 16 per cent of samples exceeded guidelines from 2010 and April 2021 (Figure 6.11). For the west of the lake (near Scrivener Dam), 50 per cent of samples exceeded guidelines (Figure 6.12). Both locations also showed occurrences of very high nitrogen concentrations. The greater number of samples exceeding guidelines in the west of the lake is likely because of additional nitrogen loads from urban inflows such as Sullivans Creek.

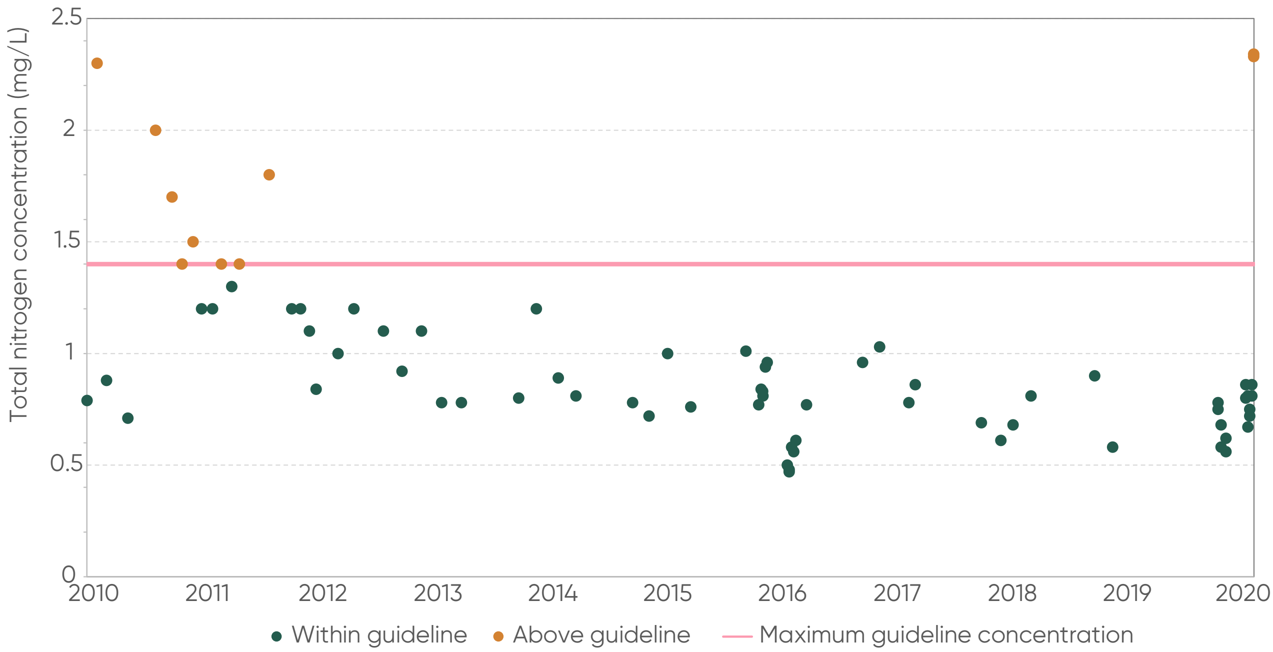



**Figure 6.11.** Total nitrogen concentrations in the surface waters of East Basin, Lake Burley Griffin, 2010 to April 2021. The pink line shows the maximum acceptable concentration for total nitrogen in the East Basin as specified in the lake Burley Griffin Water Quality Management Plan.

**Data sourced from:** National Capital Authority.

**Note:** Data from 2021 conclude at the end of the recreational season (April).

101. National Capital Authority, 2011. *Lake Burley Griffin Water Quality Management Plan 2011*. National Capital Authority, Canberra.

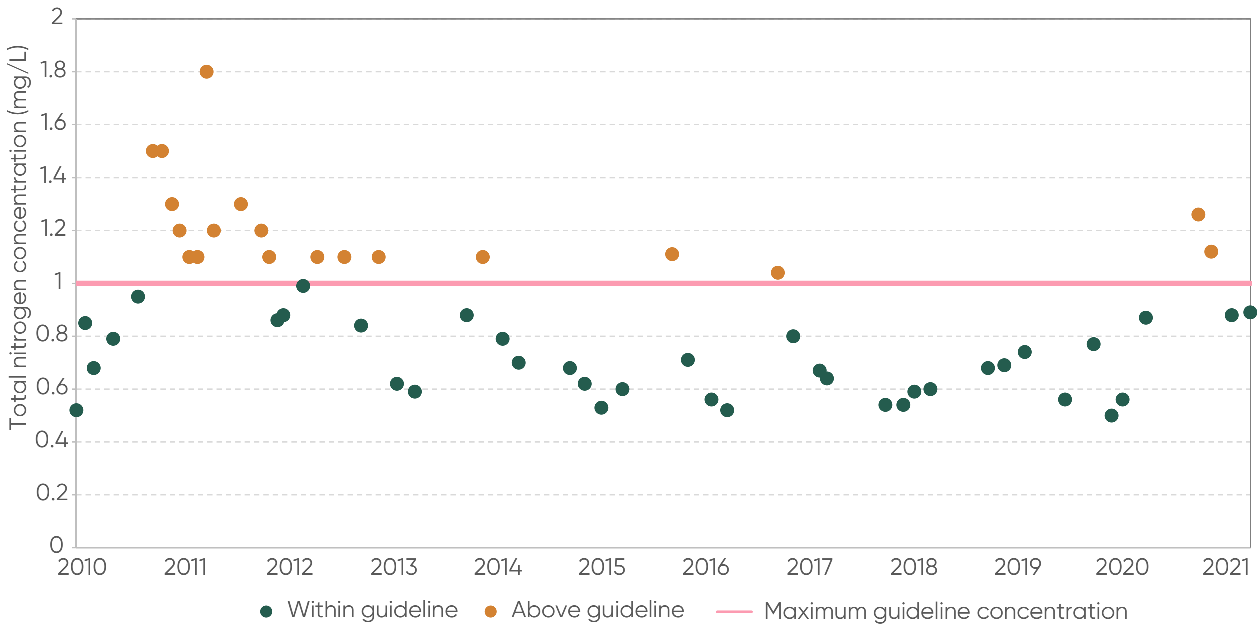



**Figure 6.12.** Total nitrogen concentrations in the surface waters near Scrivener Dam, Lake Burley Griffin, 2010 to April 2021. The pink line shows the maximum acceptable concentration for total nitrogen in the western areas of Lake Burley Griffin as specified in the lake Burley Griffin Water Quality Management Plan.

**Data sourced from:** National Capital Authority.

**Note:** Data from 2021 conclude at the end of the recreational season (April).

With the exception of 2016, the concentrations of nutrients in the surface waters of Lake Burley Griffin were broadly similar to those found in the inflows from the Molonglo River (see section **7.1 Molonglo River**)[102]. This suggests that the Molonglo River inflows are the main source of nutrients found in the lake, most likely because the Molonglo River is the major source of water to the lake (see section **6.1.3** for inflows to Lake Burley Griffin). However, other inflows remain significant sources of nutrients, particularly during heavy rainfall and during drought periods.

From 2011 to 2019, there was a steady decline in the concentrations of phosphorus (Figure 6.13) and nitrogen (Figure 6.14) in the surface waters of Lake Burley Griffin suggesting substantial improvements in the nutrient status of the lake.[103] Reduced nutrients in the lake meant that concentrations were approaching levels at which cyanobacterial blooms could have become phosphorus limited (less than 0.025 milligrams per litre).

However, nutrient concentrations notably increased again in 2020 and 2021 for both phosphorus and nitrogen (Figure 6.13 and Figure 6.14). The reasons for these changes are not clear with increases occurring across both wet and dry periods. Nutrient increases in 2020 and 2021 could be related to the greater rainfall and runoff for those years. This is supported by analysis undertaken for this Investigation which indicated a weak positive relationship between annual inflows to Lake Burley Griffin and the average annual concentrations of nutrients.

102. In 2016, the average annual phosphorus concentration was markedly higher for the Molonglo River inflows compared to concentrations in Lake Burley Griffin. The reasons for this difference are not clear.

103. Dyer, F., O'Connell, J., and Ubrihien, R., 2020. *Managing cyanobacteria in Lake Burley Griffin: Data review and recommendations. A report to the National Capital Authority from the Centre for Applied Water Science*. University of Canberra, Canberra.

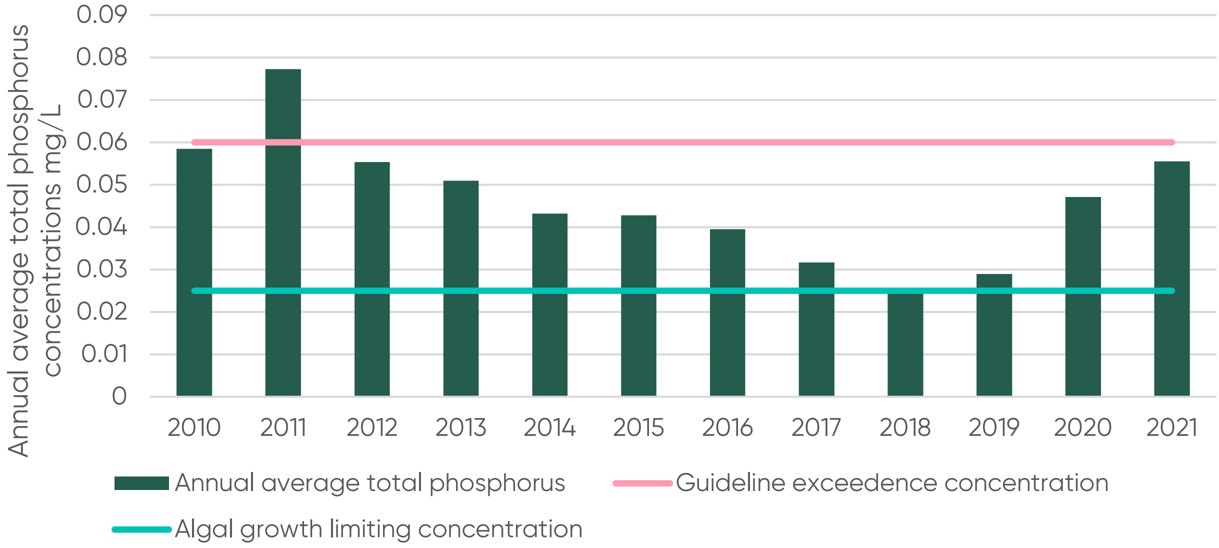



**Figure 6.13.** Annual average total phosphorus concentrations in the surface waters of Lake Burley Griffin, 2010 to April 2021. The pink line shows the maximum acceptable concentration for total phosphorus specified in the lake Burley Griffin Water Quality Management Plan. The teal line shows the concentration under which phosphorus levels are expected to limit the formation of cyanobacterial blooms.

**Data sourced from:** National Capital Authority.

**Note:** Data are averages for five sites for each calendar year. Data from 2021 conclude at the end of the recreational season (April).

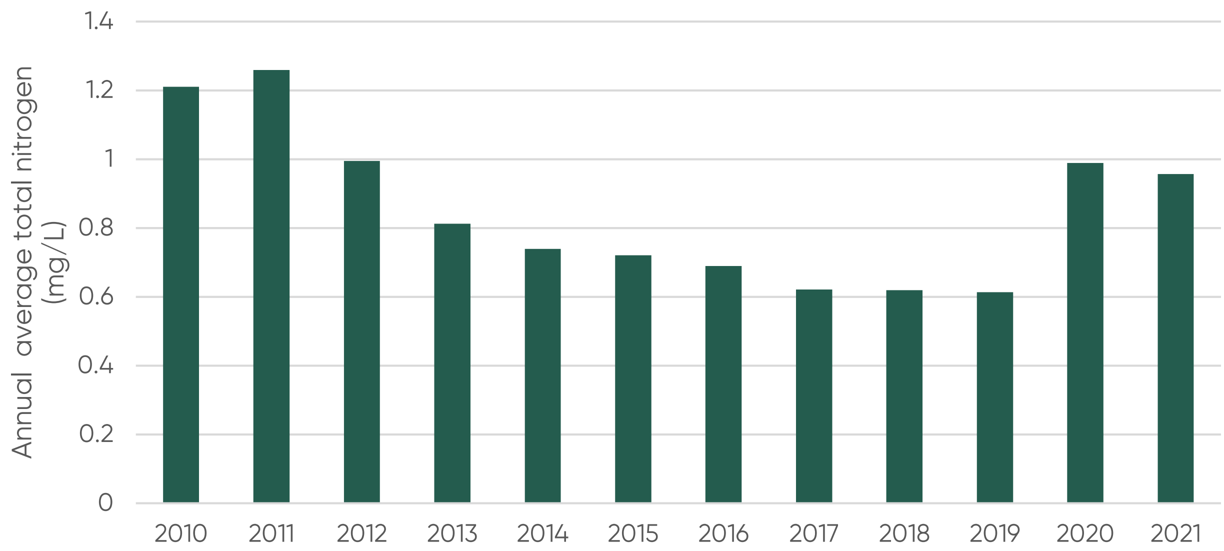



**Figure 6.14.** Annual average total nitrogen concentrations in the surface waters of Lake Burley Griffin, 2010 to April 2021.

**Data sourced from**: National Capital Authority.

**Notes:** Data are averages for five sites for each calendar year. Data from 2021 conclude at the end of the recreational season (April).

## Nutrient sources

The main sources of nutrients to Lake Burley Griffin are rural and urban runoff. However, the relative contribution of these land types, as well as from the Queanbeyan Sewage Treatment Plant (QSTP), is dependent on rainfall as this determines the volume of inflows and pollutant load from each nutrient source.

The 2012 Lake Burley Griffin Investigation included an analysis of the annual loads of nutrients contributed to the lake from urban and rural catchments, and from the QSTP (Figure 6.15).[104] The analysis showed that in wet years, rural and urban catchments contributed most of the nutrients entering the lake, accounting for 99 per cent of phosphorus (73% from rural and 26% urban), and 80 per cent of nitrogen (41% from rural and 39% from urban). Nutrient contributions from rural and urban catchments were lower in dry years accounting for 73 per cent of the total phosphorus (20% rural and 53% urban), and only 22 per cent of total nitrogen (2% rural and 20% urban). These results also show that urban catchments contribute greater nutrients to the lake during dry periods.

The QSTP makes significant nutrient contributions to Lake Burley Griffin in dry periods, accounting for 78 per cent of the nitrogen and 27 per cent of the phosphorus. The QSTP also contributes nearly one-fifth of the nitrogen in wet years but only 1 per cent of the phosphorous. It is important to note that the analysis of the annual loads of nutrients presented here was done in 2012. It would be valuable to undertake an updated analysis, especially given environmental and land use changes over the last decade.

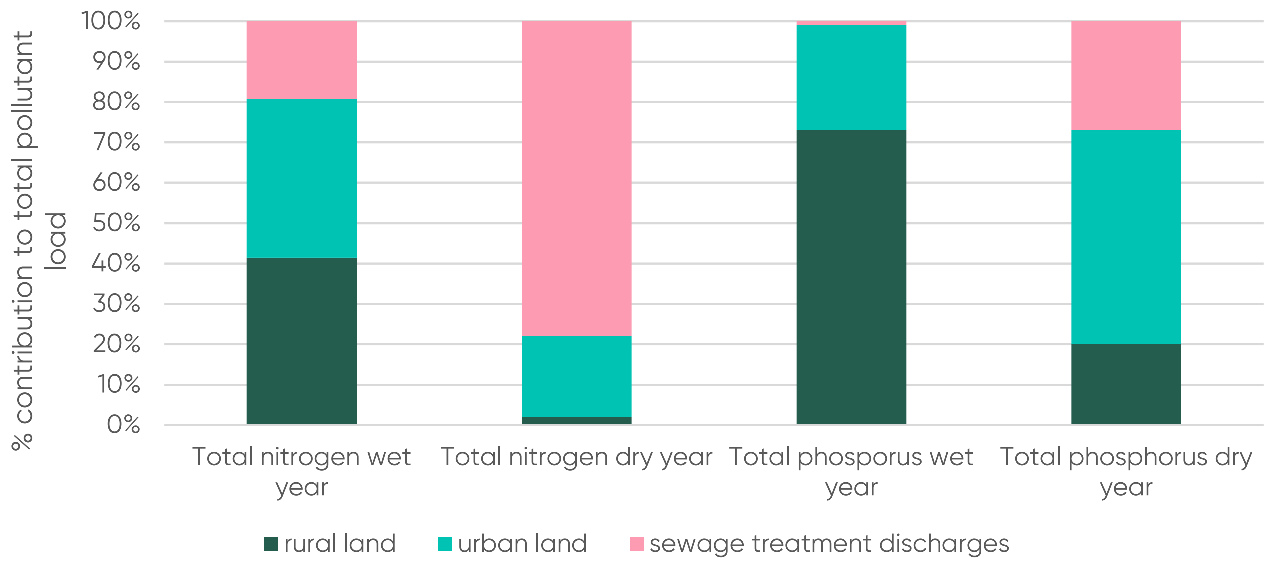



**Figure 6.15.** Wet and dry year contributions to annual Lake Burley Griffin nutrient loads from urban and rural catchments, and the Queanbeyan Sewage Treatment Plant.

**Source:** Adapted from Commissioner for Sustainability and Environment, 2012, *Report on the State of the Watercourses and Catchments for Lake Burley Griffin.*

104. Office of the Commissioner for Sustainability and Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.

These results demonstrate the need to reduce the pollutant loads entering Lake Burley Griffin from rural and urban catchments. They also show the benefit of improving the quality of discharges from the planned replacement of the QSTP to decrease the significant nutrient contributions from the current sewage treatment plant (see **Chapter 12: Urban development and the ACT's lakes and waterways**). Nutrient discharges from the current QSTP were noted in the environmental impact statement undertaken for the planned plant replacement. It was determined that the QSTP currently contributes approximately 30 per cent of the total nutrients to Lake Burley Griffin and is a key driver of lake water quality, including blue-green algal blooms and associated Lake closures.[105] Importantly, the QSTP is a significant source of soluble phosphorus which is immediately available to support algal growth leading to greater risk of cyanobacterial blooms.

Recent research undertaken on cyanobacterial blooms in Lake Burley Griffin also provided an assessment of nutrient sources.[106] Main findings included:

- The Molonglo River catchment was likely to be the dominant external source of nutrients to Lake Burley Griffin.
- There was an increasing contribution of nutrients from the lake's urban catchments.
- Although the nutrient load from urban catchments was found to be a small proportion of the total nutrients entering the lake, a significant portion of the nutrients in urban runoff was in dissolved form which is immediately available to support algal growth leading to greater risk of cyanobacterial blooms.
- There was evidence of contamination events that introduced very high concentrations of dissolved nutrients to Lake Burley Griffin.
- There was evidence of nutrient releases from the sediments over summer when the lake is stratified.
- There was evidence of seasonal phosphorus concentration peaks in surface waters, which are likely to be the result of the transfer of nutrients released from bottom waters to the surface layer of the lake over the warmer months.
- No significant relationship was found between nutrients concentrations in the lake and rainfall events.
- Because the nutrient concentrations in the lake appear to be following seasonal patterns rather than responding to rainfall events, it is likely that internal sources of nutrients are the major contributor.
- The concentrations of phosphorus in the sediments of Lake Burley Griffin were typically higher than those measured in Lake Tuggeranong sediments, meaning there is a greater potential source of phosphorus in Lake Burley Griffin than Lake Tuggeranong.

105. Queanbeyan-Palerang Regional Council, 2020. *Draft Queanbeyan Sewage Treatment Plant Upgrade Environmental Impact Statement*. Queanbeyan-Palerang Regional Council, Queanbeyan.

106. Dyer, F., O'Connell, J., and Ubrihien, R., 2020. *Managing cyanobacteria in Lake Burley Griffin: Data review and recommendations. A report to the National Capital Authority from the Centre for Applied Water Science*. University of Canberra, Canberra.

The assessment of nutrients in Lake Burley Griffin shows much complexity for sources, nutrient forms and cycles within the lake. It is evident that improved knowledge on nutrients in the lake is required to inform future management actions and reduce nutrient levels and the occurrence of algal blooms.

### Phosphorus targets

The acceptable range, or management target, for total phosphorus in Lake Burley Griffin (a concentration of less than 0.06 mg/L) has been based on the historically recorded range of concentrations in the lake. However, it is suggested that this range lacks relevance to the biological processes of Lake Burley Griffin, specifically with regard to preventing algal blooms. Phosphorus is recognised as the limiting nutrient for cyanobacterial blooms in lake systems and there is some thought that concentrations below 0.025 milligrams per litre are limiting to such blooms.[107] As part of a broader strategy to reduce the incidence of cyanobacterial blooms and improve the water quality in Lake Burley Griffin, consideration should be given to developing more appropriate phosphorus targets for the lake, in conjunction with targets for the inflowing streams.

### Turbidity

Lake Burley Griffin's turbidity levels are generally expected to decrease along the length of the lake. This is because as water moves from east to west through the lake, the fine sediment transported by lake inflows settle out of the water column. This means that the turbidity levels considered to be acceptable in Lake Burley Griffin are dependent on the location. For the East Basin, a turbidity level of under 40 NTU is acceptable, and for the West Lake, a turbidity of under 20 NTU is acceptable.

Turbidity monitoring results show:

- For East Basin, only 5 per cent of turbidity samples from 2010 to April 2021 were outside the acceptable range. The few instances of high turbidity corresponded to very high rainfall events, for example, a turbidity of more than 60 **NTU**[108] in February 2018 was caused by 60 mm of rainfall in the preceding 24 hours.
- For West Lake, around 16 per cent of turbidity samples from 2012 to April 2021 were outside the acceptable range, most frequently in wetter years. Turbidity was rarely above 40 NTU in the West Lake area. Because there was no turbidity data for the wetter years of 2010 and 2011, the percentage of guideline exceedances would most certainly be higher if calculated over the same period as the East Basin and Scrivener Dam sites.
- Turbidity levels near Scrivener Dam are the lowest of the three locations, which is expected given it is furthest from Lake Burley Griffin's main inflow (the Molonglo River) in the East Basin. However, turbidity was found to be above the acceptable level for nearly 18 per cent of samples taken from 2010 to April 2021, mainly in the high rainfall years of 2010 and 2011.

107. Dolman, A. M., et al., 2012. *Cyanobacteria and Cyanotoxins: The Influence of Nitrogen versus Phosphorus*. PLOS ONE 7(6):e38757.

108. NTU stands for Nephelometric Turbidity unit. It is a measure of water clarity based on the amount of light scattered by particles in the water column. Particles can be organic such as algal cells, and inorganic such as fine sediment. Water with a high NTU has elevated concentrations of suspended particles and often looks dirty. The water can appear brown or green, as well as other colours, dependent on the type of suspended particles.

Annual average turbidity results show that the expected east to west improvement in turbidity is occurring (Figure 6.16). However, monitoring also reveals periods where this is not being achieved, particularly during high rainfall when high turbidity levels in urban inflows increases turbidity throughout the lake.



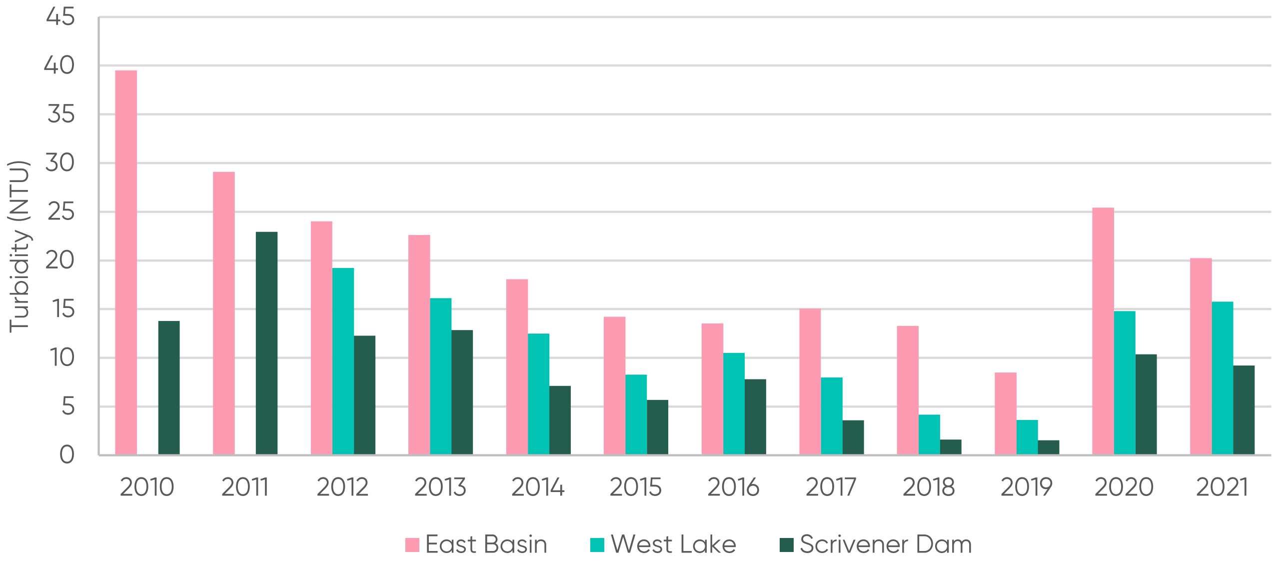



**Figure 6.16.** Annual average turbidity in the surface waters of Lake Burley Griffin for East Basin, West Lake and near Scrivener Dam, 2010 to 2021.

**Data sourced from:** National Capital Authority.

**Notes:** Data are averages for each calendar year. Data from 2021 conclude at the end of the recreational season (April). West Lake data not available for 2010 and 2011.

There has been little change in the turbidity levels of East Basin in the past 10 years and a comparison with data prior to 2010 suggests consistency in this part of the lake since the mid-1980s. Turbidity within the West Lake was observed to be consistently below 20 NTU during the Millennium Drought years of 2000–2010, and it was similarly low in 2015, 2016, 2018 and 2019. In wetter years, the turbidity in the West Lake, while still lower than the East Basin, is higher compared to dry years. The influence of wetter years on turbidity levels in Lake Burley Griffin shows that rural and urban runoff are the main causes of high turbidity. The 2012 Lake Burley Griffin Investigation included an analysis of the annual loads of suspended solids contributed to the lake from urban and rural catchments.[109] Although it should be noted that turbidity and suspended solids are separate water quality measures, they are related as high levels of suspended solids increase turbidity. The 2012 analysis showed that in wet years, rural catchments contributed 87 per cent of the suspended solids, and urban catchments 13 per cent. The contributions from urban catchments increased to nearly 40 per cent in dry years. It is important to note that this analysis was done in 2012. It would be valuable to undertake an updated analysis, especially given environmental and land use changes over the last decade, particularly in terms of urban development.

109. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.

## pH

The pH in Lake Burley Griffin was consistently within the acceptable range for the 2010 to April 2021 period, with only 3 per cent of readings above the upper limit of 8.5 and none below the lower limit of 6.5. There was a slight increase in pH from 2016 to 2019 which was likely caused by changes in the lake's inflows. Typically, pH in Lake Burley Griffin is slightly higher in the drier periods, reflecting the increased contributions from groundwater through creek and river baseflows, and from urban stormwater channel inputs (delivered via concrete drains). During very dry years, baseflow and stormwater channel inflows will account for significant proportions of Lake Burley Griffin's total inflows resulting in higher pH levels.

## Dissolved oxygen

For the 2010 to April 2021 period, dissolved oxygen concentrations in the surface waters of Lake Burley Griffin were generally well above levels of concern ranging between 7 and 9 milligrams per litre. There were only very rare (<0.5% of readings) and isolated instances where concentrations were below acceptable levels. Dissolved oxygen concentrations in the bottom waters are lower and are consistent with those of lakes that stratify over summer.

## Conductivity

For the 2010 to April 2021 period, conductivity (a measure of salt concentration) in the surface waters of Lake Burley Griffin was almost always within the acceptable range, with extremely rare instances of values exceeding guideline levels. The conductivity of the lake water increased from 2013 to 2019, possibly because of drier conditions combined with the increased contributions from creek and river baseflows and urban stormwater channels which tend to have higher conductivity levels. The return of wetter conditions in 2020 and 2021 saw conductivity levels declining again.

## Maintaining downstream water quality

One of the key environmental benefits of Lake Burley Griffin is the improvement of water quality along its length as sediment and nutrients settle in the slow flowing waters of the lake. The expected improvements are reflected in water quality guidelines that specify lower target levels (reduced pollutants) for nitrogen and turbidity for the downstream West Lake area compared to the upstream East Basin.[110] The East Basin is where most of the lake's annual water inflows and expected pollutant loads occur.

Although there is the expectation that water quality should improve as it moves along Lake Burley Griffin, the lake's water quality attenuation performance is complex. Water quality improvements between upstream and downstream lake areas are not only dependent on the type of pollutant but also conditions including rainfall, inflow volumes, temperature and wind. Water quality levels in West Lake are

110. Water quality targets are outlined in: National Capital Authority, 2011. *Lake Burley Griffin Water Quality Management Plan 2011*. National Capital Authority, Canberra. Water quality targets specified for East Basin are: Nitrogen 1.4 milligrams per litre and Turbidity 40 NTU; For West Lake: Nitrogen 1.0 milligrams per litre and Turbidity 20 NTU.

also strongly influenced by the inflows from Sullivans Creek which can introduce large loads of pollutants. This means that there is much variation in the upstream and downstream pollutant concentrations measured in the lake, as well as for the urbanised inflows to the lake (see Figure 6.17, Figure 6.18 and Figure 6.19).

Despite the variation in upstream and downstream pollutant levels, the lake can be seen to be effectively mitigating some of the effects of urbanisation for the downstream receiving waters. This is evidenced by periods of similarity between, or reductions in, pollutant levels when comparing the upstream and downstream areas of Lake Burley Griffin (see pollutant sections below). Such results also demonstrate that the lake prevents the pollution from its urbanised tributaries reaching the downstream waters of the Lower Molonglo and Murrumbidgee Rivers. This is particularly important as these urbanised tributaries can at times have significantly higher pollutant concentrations than the Molonglo River inflows upstream.

Changes to individual pollutant levels upstream and downstream of Lake Burley Griffin are discussed below.

## Phosphorus

From 2010 to April 2021, the concentrations of phosphorus in the Molonglo River were not only similar upstream and downstream of Lake Burley Griffin (Figure 6.17) but also were substantially lower than those from the urban catchment inflows of Sullivans Creek. These results indicate that the lake is acting to trap the phosphorus from the urban runoff.

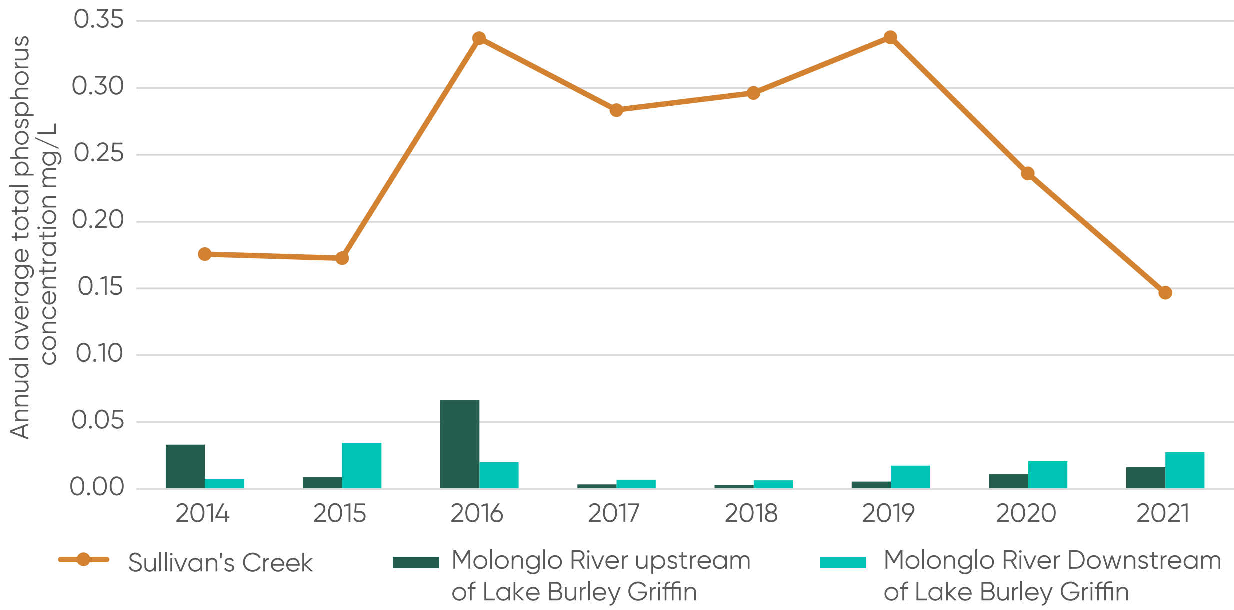



**Figure 6.17.** Annual average total phosphorus concentrations in the inflows to Lake Burley Griffin from the Molonglo River and Sullivans Creek, and for the Molonglo River downstream of the lake, 2014 to 2021.

**Data sourced from:** ACT Government and Waterwatch ACT.

**Notes:** Data are averages for each calendar year. Data from 2021 conclude at the end of the recreational season (April).

## Nitrogen

Nitrogen (as nitrate) concentrations from 2010 to April 2021 were typically higher in the Molonglo River upstream of Lake Burley Griffin compared with those recorded downstream (Figure 6.18). This is as expected because of the levels in the treated discharges from the Queanbeyan Sewage Treatment Plant.[111] The nitrogen concentrations in Sullivans Creek are highly variable, sometimes similar to those recorded in the Molonglo River downstream of Lake Burley Griffin, and at other times much higher or lower. This variation in Sullivans Creek is likely the result of differences in rainfall and urban runoff, and the occurrence of high pollution events.

The lower nitrogen concentrations downstream of Lake Burley Griffin show that the lake is mitigating the potential effects of nitrogen from the urbanised tributaries and from the Queanbeyan Sewage Treatment Plant, effectively protecting the waters downstream of the lake. This mitigation occurred even when nitrogen concentrations were elevated in Sullivans Creek.

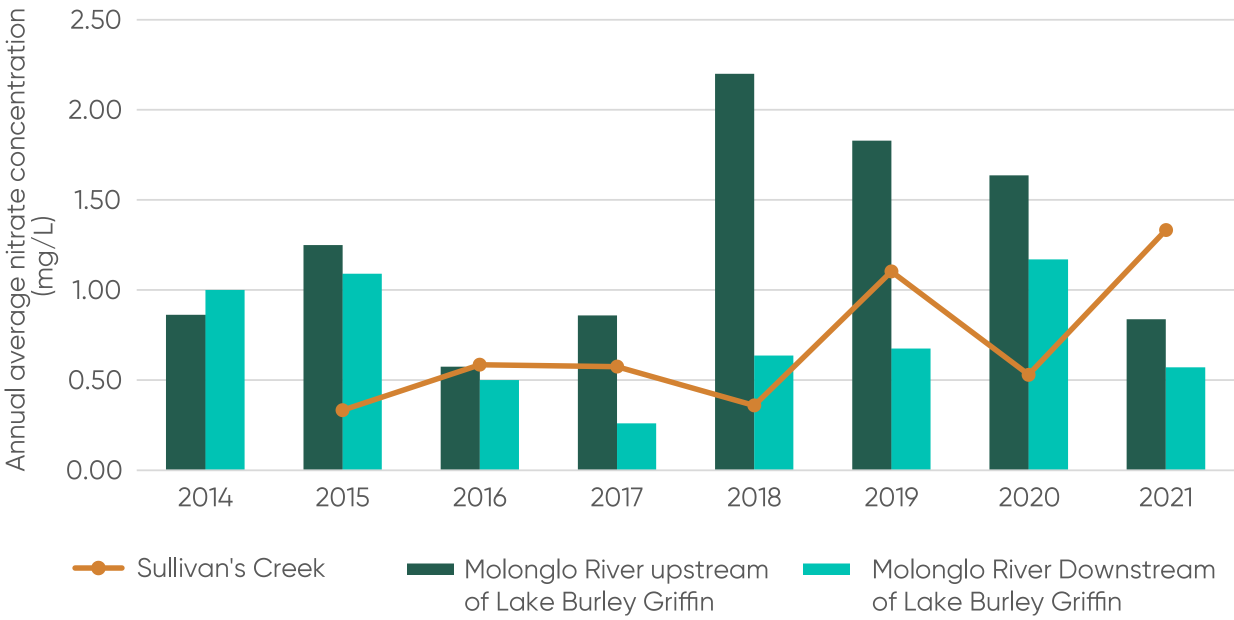



**Figure 6.18.** Annual average nitrate concentrations in the inflows to Lake Burley Griffin from the Molonglo River and Sullivans Creek, and for the Molonglo River downstream of the lake, 2014 to 2021.

**Data sourced from:** ACT Government and Waterwatch ACT.

**Notes:** Data are averages for each calendar year. Data from 2021 conclude at the end of the recreational season (April).

111. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.

## Turbidity

Turbidity concentrations recorded downstream of Lake Burley Griffin from 2010 to April 2021 were similar to the levels found in the lake's inflows from the Molonglo River and Sullivans Creek (Figure 6.19). This is with the exception of 2020 when the turbidity recorded in the Molonglo River downstream of Lake Burley Griffin was markedly higher than upstream but similar to the concentrations in Sullivans Creek. These results followed some very high turbidity concentrations in January, June and August 2020. While the high concentrations were associated with rainfall days, the rain was not atypical and there is not an obvious reason for the high concentrations.

The similarity in turbidity concentrations in most years shows the lake is generally protecting the waters downstream, mitigating the potential effects of turbidity from the urbanised tributaries. This is evidenced by the lack of a significant increase in downstream turbidity concentrations even when turbidity is higher for the Sullivans Creek inflows. However, the data from 2020 demonstrates how variable pollutant levels in Lake Burley Griffin are in response to conditions that significantly increase inflows of pollutants. Such occurrences can result in higher pollutant concentrations downstream of the lake.

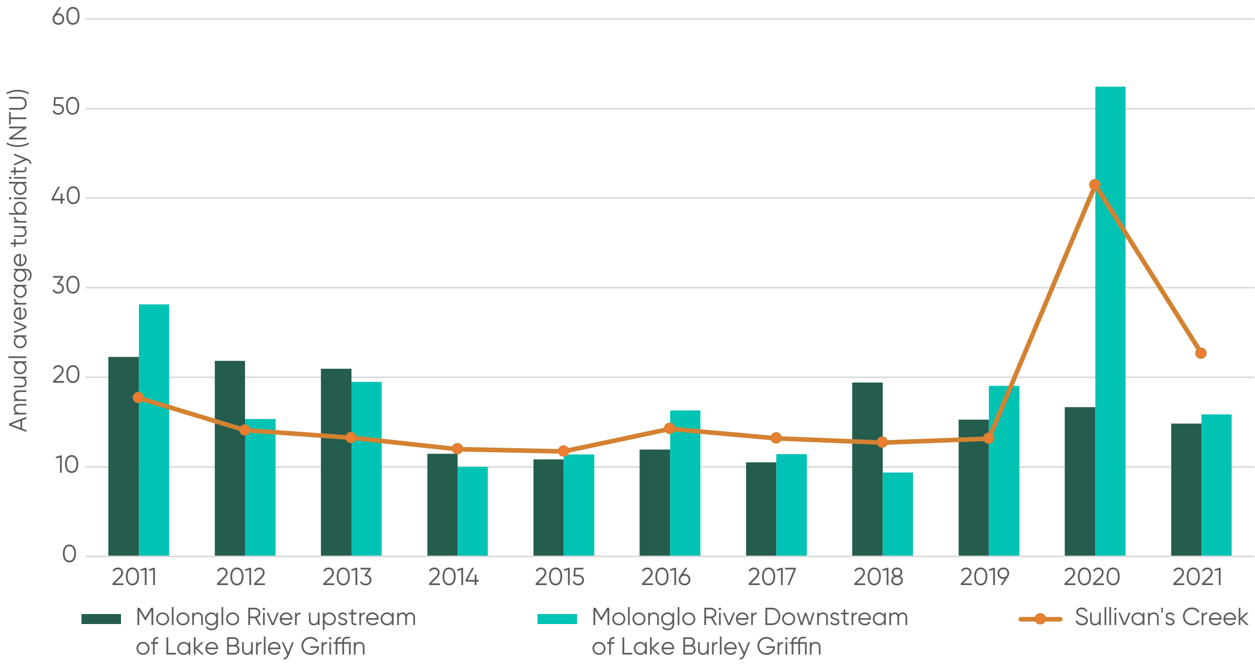



**Figure 6.19.** Annual average turbidity concentrations in the inflows to Lake Burley Griffin from the Molonglo River and Sullivans Creek, and for the Molonglo River downstream of the lake, 2011 to 2021.

**Data sourced from:** ACT Government and Waterwatch ACT.

**Notes:** Data are averages for each calendar year. Data from 2021 conclude at the end of the recreational season (April).

## Biodiversity and ecosystem health of Lake Burley Griffin

Although it is considered that the aquatic ecosystems of Lake Burley Griffin have not changed markedly over the past 30 years, there are limited data available to determine any trends in the broader biodiversity and ecological values of the lake. Some limited information on selected ecosystem values is discussed below.

## Macrophyte condition

The loss of aquatic macrophytes that were prevalent in the East Basin between Springbank Island and the Acton Foreshore in the 1980s has perhaps been the most significant change to Lake Burley Griffin's ecosystem health. The 2012 Investigation on Lake Burley Griffin expressed concerns about the substantial loss of macrophyte beds, describing the loss as a significant ecosystem change.[112] Although recent surveys have not been undertaken for the lake, observations confirm areas that once supported macrophyte communities remain devoid of macrophyte beds. This suggests that the lake has reached an alternate stable state that is dominated by phytoplankton rather than macrophytes. The reasons for this are unclear but are likely caused by a combination of increased nutrients and turbidity, and hydrological changes. It is also considered that macrophyte loss may be partly attributable to high numbers of carp which are known to adversely affect macrophyte growth.[113, 114]

Macrophytes still remain in other areas of Lake Burley Griffin, particularly in the western areas. However, without regular surveys, it is not possible to determine if these have changed over time.

## Algae

The algal communities occurring in Lake Burley Griffin vary throughout the year, displaying the expected algal successional processes of a reasonably nutrient rich environment. It is notable that the prevalence of extreme cyanobacterial concentrations has increased over the past 10 years and is likely to be a regular feature of the lake given the current nutrient concentrations in the surface waters.

## Fish

Regular stocking has seen nearly 670,000 native fish stocked to selected Canberra waters from 2011–12 to 2020–21.[115] For Lake Burley Griffin, this includes the stocking of around 138,000 Murray Cod and 142,000 Golden Perch from 2011–12 to 2020–21. This accounts for some 45 per cent of the Murray Cod stocked to Canberra's urban waters, and nearly 40 per cent of the Golden Perch. In addition to stocked fish, self-sustaining populations of Western Carp Gudgeon are known to be present in Lake Burley Griffin.

Fish populations in Lake Burley Griffin are surveyed every two–three years by the ACT Government. Results show that the water quality and ecosystem health of the lake are sufficient for the survival of stocked native fish, with no evidence of high mortality rates or fish kill events.

112. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.

113. Miller, S. A. and Crowl, T. A., 2006. *Effects of common carp (Cyprinus carpio) on macrophytes and invertebrate communities in a shallow lake*. Freshwater Biology 51(1): 85–94.

114. Vilizzi, L., et al., 2014. *Ecological effects of common carp (Cyprinus carpio) in a semi-arid floodplain wetland*. Marine and Freshwater Research 65(9): 802–817.

115. Environment and Planning Directorate, 2015. *Fish stocking plan for the Australian Capital Territory 2015–2020*. ACT Government, Canberra.

It is interesting to note that following the establishment of Lake Burley Griffin in 1964, the emphasis for fish stocking was on the introduced species Rainbow Trout and Brown Trout. However, by the mid 1980s it was evident the trout in the urban lakes and in nearby rivers showed poor survival and growth rates. As native fish became commercially available, the stocking of trout was replaced by native species. It is unclear why trout populations declined but it is thought that possible causes include reductions in water quality, decreased lake biotic production, presence of pest species and increased lake water temperatures.[116]

The lake supports self-sustaining populations of European Carp and Redfin Perch, both invasive species that have negative effects on water quality and other fish species.

## Other flora and fauna

Lake Burley Griffin provides valuable habitat for a variety of water dependent and terrestrial species. It supports populations of aquatic plants, mammals, invertebrates and waterbirds. There are submerged aquatic plants as well as reeds and rushes in the lake margins, particularly in the western areas. Significant ecological assets of Lake Burley Griffin include:

- bird habitat at Jerrabomberra Wetlands, used by migratory waterbird species that are protected under the international migratory bird agreements including the Japan Australia Migratory Bird Agreement, the China–Australia Migratory Bird Agreement and the Republic of Korea–Australia Migratory Bird Agreement
- reedbeds along inlets in Yarramundi Reach that are also valuable waterbird habitat, and
- habitat on the foreshores for endangered plant and animal species including Button Wrinklewort (*Rutidosis leptorrhynchoides*) and Striped Legless Lizard (*Delma impar*).

Lake Burley Griffin is also home to Rakali (or Australian water rat), with frequent observations from citizen science programs across the lake.[117] Rakali are top predators and scavengers and appear to thrive on introduced fish species such as carp and redfin. They appear relatively oblivious to poor water quality and seem to be most frequently associated with areas where there are stable banks covered in low growing vegetation or emergent aquatic vegetation.

116. Draft ACT Government. *Fish stocking plan for the Australian Capital Territory 2021–2026*. Unpublished.

117. Williams, G. A., 2019. *Distribution and status of the Australian water rat/Rakali (Hydromys chrysogaster) in the greater ACT region*. A report by the Australian Platypus Conservancy to the Wettenhall Environment Trust.

### 6.1.5 Knowledge gaps for Lake Burley Griffin

This Investigation has found the following key knowledge gaps for Lake Burley Griffin:

- Internal sources of nutrients are likely to be an important driver of cyanobacteria blooms in the lake but this cannot be confirmed because nutrient data is lacking for the bottom waters of the lake. To better understand the drivers of cyanobacteria blooms, the relative contributions of internal and external sources of available nutrients need to be quantified.
- Rainfall conditions are a major determinant of the sources and loads of pollutants entering Lake Burley Griffin, with urban inflows delivering a greater proportion of the total pollutants in dry years. However, the relative flow and pollutant contributions from many of the urban inflows are estimates only with long-term data only available for Sullivans Creek. Given the importance of the urban catchments for delivering pollutants and organic matter to Lake Burley Griffin, improved monitoring of the urban inflows is needed, particularly from the stormwater network on the south of the lake.
- Phosphorus concentrations in the surface waters of Lake Burley Griffin declined from 2011 to 2019, with levels in 2018 and 2019 reduced to the point where algal blooms would be limited by the availability of nutrients. This reduction appears to be driven by similar phosphorus decreases in the Molonglo River upstream of the lake, although the reasons for the decline are not clear. Further investigation to understand the drivers of this decline may assist in managing nutrient concentrations and algal blooms in the lake.
- Current monitoring programs do not enable any assessment of the impacts of foreshore and catchment land developments on Lake Burley Griffin. This includes the likely water quality issues caused by the increased runoff of pollutants during construction. There needs to improved monitoring, during and post construction, to assess the effectiveness and compliance of pollution control structures and water sensitive urban design measures. This knowledge is necessary to inform ongoing maintenance requirements for pollution control infrastructures, as well as to improve the future design of pollution prevention measures.
- To understand the source and volume of pollutants entering the lake, more frequent monitoring needs to occur, including events-based monitoring that assesses periods of high pollutant loads during rainfall events.

For information on improving water quality and ecosystem health information see section **11.8 Effectiveness of monitoring, evaluation and reporting processes for urban waters**.

Black Swan family. Source: Ryan Colley

# 6.2 Lake Tuggeranong



*Aerial photo of Lake Tuggeanong with blue-green algae bloom. Source:  Alica Tschierschke*

### 6.2.1 Lake Tuggeranong main findings and key actions

#### Condition assessment against management and community values

The values used to assess the state of Lake Tuggeranong are based on selected key requirements for the quality of water as outlined in the Canberra Urban Lakes and Ponds Land Management Plan.[118] This includes assessing whether the water quality and aquatic health of Lake Tuggeranong support recreational, aesthetic and ecological values, and whether the lake maintains downstream water quality and flow.[119] The assessments are informed by the data findings discussed in section **6.2.3 Data trends for Lake Tuggeranong**.

118. Environment, Planning and Sustainable Development Directorate, 2022. *Canberra Urban Lakes and Ponds Land Management Plan*. ACT Government, Canberra.

119. Recreational activities include primary contact such as swimming.

| Value | Status | Condition | Trend | Data quality |
|---|---|---|---|---|
| LT1: Does the water quality in Lake Tuggeranong support recreational and aesthetic values? | Lake Tuggeranong often has poor water quality and regularly suffers from cyanobacterial blooms and high levels of faecal contamination. These are often accompanied by odours and highly turbid water, reducing the recreational and aesthetic value of the lake and surrounds. Since 2015–16, the lake has been frequently closed over the recreational season. In 2016–17 and 2020–21, it was closed for around 80 per cent of the recreational season, mainly because of high concentrations of cyanobacteria. In Lake Tuggeranong these blooms are driven by high concentrations of nutrients transported to the lake in urban runoff. | Poor | ↓ | ●●● High |
| LT2: Does the aquatic health of Lake Tuggeranong support ecological values? | There is little comprehensive long-term information on the ecological values of the lake to provide an assessment with a high level of confidence. Current knowledge is limited to Waterwatch assessments undertaken from 2018 to 2020, which found lake macroinvertebrate communities to be poor, and riparian condition to be poor to degraded. It is considered that the water quality and ecosystem health of the lake are sufficient for the survival of stocked native fish, with no evidence of high mortality rates. | Fair | ? | ●●● Moderate |
| LT3: Does Lake Tuggeranong maintain downstream water quality and flow? | **Water quality**<br>Lake Tuggeranong does not appear to be consistently mitigating the effects of urbanisation for the downstream receiving waters. This is evidenced by periods of higher phosphorus and nitrogen concentrations in Tuggeranong Creek downstream of the lake, compared to those recorded upstream. However, phosphorous and turbidity concentrations downstream were lower than in-lake levels for most years. This may indicate that Lake Tuggeranong is mitigating pollution at times. The lack of data on the inflow of pollutants to the lake means that confidence in this assessment is low. | Fair | ? | ●●● Moderate |
| | **Flow**<br>The lack of flow data upstream of the lake means that it is not possible to determine if flows from Lake Tuggeranong maintain the health of waterways downstream. | Unknown | ? | ●●● Low |

## Indicator assessment legend

### Condition

- Good = Environmental condition is healthy OR pressure likely to have negligible impact on environmental condition/human health/waterbody values.
- Fair = Environmental condition is neither positive or negative OR pressure likely to have limited impact on environmental condition/human health/waterbody values.
- Poor = Environmental condition is under significant stress, OR pressure likely to have significant impact on environmental condition/human health/waterbody values.
- Unknown = Data is insufficient to make an assessment of status and trends.

### Trend

- ↑ Improving
- ↓ Deteriorating
- - Stable
- ? Unclear

### Data quality

- ●●● High = Adequate high-quality evidence and high level of consensus
- ●●● Moderate = Limited evidence or limited consensus
- ●●● Low = Evidence and consensus too low to make an assessment

## Lake Tuggeranong main findings

**Inflows and outflows**

- All inflows to Lake Tuggeranong are ungauged, meaning that is not possible to determine the volume of inflows to the lake. It is likely that they are highly variable with the heavily urbanised catchment and associated impermeable surfaces generating large flow changes in response to rainfall events.
- In the absence of inflow data, it is not possible to determine what proportion of the lake's inflows are released downstream. However, it is assumed that during times when the lake is full, outflows are equivalent to inflows. Whereas in drought periods, it is likely outflows are lower than inflows to maintain the water level in the lake.
- The lack of flow data means that it is not possible to determine if Lake Tuggeranong outflows are adequate to maintain the health of downstream waterways.

**Water quality**

- Lake Tuggeranong has a reputation for poor water quality and regularly suffers from cyanobacterial blooms and high levels of faecal contamination. These are often accompanied by odours and highly turbid water, reducing the recreational and aesthetic value of the lake and surrounds.
- A significant issue affecting the aquatic health of Lake Tuggeranong is its small size in comparison to its catchment area.
- The main pressure on the lake's water quality is the significant inflow of pollutants from urban areas which occupy 50 per cent of the catchment. Urban development is continuing in the catchment, which will likely further degrade water quality in the absence of effective pollution controls.

**Recreational water quality 2015–16 to 2020–21**

- Since 2015, the lake has been frequently closed over the recreational season. In four of those years, the lake was closed for more than 60 per cent of the recreational season, and in 2016–17 and 2020–21, it was closed for around 80 per cent of the recreational season.
- The main reason for the closures has been high concentrations of cyanobacteria in the lake, with some closures each season because of the high levels of enterococci.
- The frequent recreational closures clearly demonstrate a failure to meet the community's recreational and aesthetic expectations for Lake Tuggeranong.

**Levels of cyanobacteria 2010 to July 2021**

- Around 56 per cent of the cyanobacteria samples taken had low concentrations, around 33 per cent had medium concentrations, 6 per cent had high concentrations and 5 per cent had extreme concentrations.

- There are regular occurrences of extreme cyanobacteria concentrations over the summer period, with peaks from mid-summer onwards.
- Cyanobacterial blooms in Lake Tuggeranong are likely driven by high concentrations of nutrients, particularly phosphorus, transported to the lake in urban runoff.
- Nutrient concentrations are also increased by the release of nutrients from sediments, particularly in response to low dissolved oxygen levels.
- Climate change is predicted to further increase the occurrence of cyanobacterial blooms in Lake Tuggeranong.
- The quality of water entering Lake Tuggeranong must be improved for there to be any reduction in the occurrence and severity of cyanobacterial blooms. Especially important is the need to make significant decreases in the lake's nutrient and sediment concentrations, as well as the organic matter entering the lake.
- The Tuggeranong community has an important role in preventing algal blooms in the lake, particularly in decreasing the levels of nutrients and organic matter from entering the stormwater system.

**Nutrients 2010 to July 2021**

- Nutrient concentrations in Lake Tuggeranong were regularly above the acceptable levels for urban lakes and were sufficiently high to support a bloom throughout the year.
- The main source of nutrients in Lake Tuggeranong were inflows of rainfall runoff from the urban catchment.
- Concentrations of phosphorus observed in the surface waters of Lake Tuggeranong were more than three times the levels at which cyanobacteria are likely to be the dominant phytoplankton present.
- Around 12 per cent of the recorded phosphorus concentrations were above the acceptable range. This would be as high as 50 per cent if the lower phosphorus guideline levels applied to Lake Burley Griffin were used.
- Annual average phosphorus concentrations were below the acceptable range for all years except 2010 and 2011. However, results show concentrations do exceed the acceptable range on many occasions.
- Around 80 per cent of the recorded nitrogen concentrations were above the acceptable range, with some notable high concentrations evident.
- Annual averages for nitrogen were well above the acceptable range for all years except 2013.
- Although nutrients from in-lake sources (e.g. sediment, organic matter) account for only 20 per cent of nutrients in the lake, they still represent a substantial contribution.
- Almost half of the phosphorus entering the lake in stormwater flows was in dissolved form and readily available for uptake by cyanobacteria.
- Runoff from sporting fields contributed higher concentrations of nutrients than other land uses in the Lake Tuggeranong catchments.
- Under baseflow conditions Village Creek and Wanniassa stormwater catchment typically had the highest nutrient concentrations.

- An accurate determination of nutrient sources requires a much better understanding of the main catchment inflows and the pollutant loads they transport during rainfall events. This can only be obtained through improved events-based monitoring.

**Other water quality parameters 2010 to July 2021**

- Although turbidity levels were generally within, or close to, water quality guidelines, around 22 per cent of records were above the acceptable range for ACT lakes. There were also extremely high periods of turbidity, including 400 NTU recorded in April 2014.
- Annual average turbidity was higher than the acceptable range for three years from 2010 to 2021. This is likely in response to periods of high turbidity caused by heavy rainfall or pollution events.
- Dissolved oxygen concentrations, pH, and conductivity were consistently within the acceptable range with few exceedances of water quality guidelines.

**Maintaining downstream water quality 2014 to July 2021**

- Lake Tuggeranong does not appear to be consistently mitigating the effects of urbanisation for the downstream receiving waters.
- There were periods of higher phosphorus and nitrogen concentrations within and downstream of the lake compared to upstream of the lake.
- However, phosphorous concentrations downstream of the lake were lower than in-lake levels for most years. This may indicate that Lake Tuggeranong is mitigating phosphorus pollution at times.
- Higher nitrogen concentrations were found for the downstream site compared to in-lake levels for most years suggesting Lake Tuggeranong is less effective at mitigating nitrogen pollution.
- However, the lack of data for all the main inflows to Lake Tuggeranong makes upstream to downstream comparisons difficult — the long-term data are only available for Tuggeranong Creek. Given that other inflows to Lake Tuggeranong are known to have higher nutrient concentrations, it may be that the lake is somewhat mitigating the impact of the nutrient inflows to the lake.
- Turbidity downstream of the lake was lower compared to in-lake levels for all but one year. This suggests that the lake is mitigating turbidity pollution in most years.
- Turbidity in the lake was sometimes greater than that recorded in the upstream and downstream sites in Tuggeranong Creek. This is likely the result of monitoring being undertaken in Tuggeranong Creek during low flows when the water was generally clear.
- Rainfall event-based sampling is required to obtain an accurate assessment of turbidity and nutrient levels upstream and downstream of Lake Tuggeranong, particularly as the majority of pollutants are transported to the lake under high flow conditions.

**Biodiversity and ecosystem health**

- There are little data available that would allow trends in the broader ecological values of Lake Tuggeranong to be determined.
- Waterwatch provides the only systematic and regular evaluation of Lake Tuggeranong's ecological condition. Waterwatch surveys have found macroinvertebrate communities to be in poor condition and riparian zones to be in poor to degraded condition, although the riparian assessment methodology used is perhaps not suitable for the lake's highly managed environments.
- Regular stocking has seen around 36,700 Murray Cod and 34,400 Golden Perch released to the lake from 2011–12 to 2020–21. This accounts for 10 per cent of these species stocked to Canberra's urban waters.
- The water quality and ecosystem health of the lake are sufficient for the survival of stocked native fish, with no evidence of high mortality rates.
- Lake Tuggeranong supports self-sustaining populations of European Carp and Redfin Perch, both introduced species that have negative effects on water quality and other fish species.

## Lake Tuggeranong key actions

That the ACT Government:

**Key Action 6.8:** Analyse catchment pollutant sources and loads for Lake Tuggeranong. Analysis should include all main inflows, estimates for periods of high and low lake inflows, and for both dissolved and particulate forms of nutrients.

**Key Action 6.9:** Improve flow data for the main catchment inflows to Lake Tuggeranong to enable assessments of pollutant loads and the effectiveness of water quality management.

**Key Action 6.10:** Undertake research to determine factors driving increased algal blooms in Lake Tuggeranong, including nutrient release from lake sediments and organic matter loads.

**Key Action 6.11:** Develop more appropriate phosphorus targets for Lake Tuggeranong, in conjunction with targets for the inflowing streams, as part of a broader strategy to reduce the incidence of cyanobacterial blooms.

**Key Action 6.12:** Increase water sensitive urban design measures to reduce nutrient and other pollutant loads entering Lake Tuggeranong. This should include interventions to allow increased water infiltration, reduce flow rates and increase water retention in the catchment, and reduce the runoff of nutrient loads from playing fields.

**Key Action 6.13:** Develop and implement strategies and programs to reduce the amount of organic matter entering Lake Tuggeranong including leaf litter and other organic matter from urban areas. Particular focus should be given to community actions and current ACT Government street sweeping practices.

## 6.2.2 Pressures on the aquatic health of Lake Tuggeranong

This section discusses pressures that are specific to Lake Tuggeranong. For general water quality and aquatic health pressures see section **5.1 Impacts on Canberra's urban lakes and waterways**.

A significant pressure on the aquatic health of Lake Tuggeranong is the design of the lake itself. Prior to its construction, there was concern over the risk of poor water quality because of the small size of the lake in comparison to its catchment area. However, the lake could not be enlarged because of the urban development already established. To address the small lake size, a series of water pollution control ponds, such as the Isabella and Stranger Ponds were constructed to try and reduce the pollutants entering the lake.

Early water quality research for the development of the Tuggeranong district highlighted the water quality challenges of Tuggeranong Creek and its catchment.[120] The research noted that large volumes of stormwater runoff were transporting high concentrations of sediment, nutrients and coliform bacteria downstream to the Murrumbidgee River. The research predicted that the construction of Lake Tuggeranong would likely improve the quality of water downstream of the lake but that the lake would likely experience regular nuisance phytoplankton blooms and increased bacterial contamination with ongoing catchment development. These predictions appear to have been correct (see section **6.2.4 Water quality in Lake Tuggeranong**).

Ongoing urban development in the lake's catchment, including high density urban infill, is a significant pressure on Lake Tuggeranong's water quality and aquatic health. The development generates higher levels of pollutants that flow into the lake via Tuggeranong Creek and other inflows, including stormwater drains. This increases the burden on existing water sensitive urban design infrastructure constructed to manage pollutant loads from urban runoff. The increased pollution requires new pollution control infrastructure or improved performance from existing controls.

## 6.2.3 Data trends for Lake Tuggeranong

### Lake Tuggeranong catchment and hydrology

#### Catchment

Lake Tuggeranong drains a total catchment area of approximately 61 km$^2$, most of which is in the ACT. Urban land use dominates, accounting for around 50 per cent of the total catchment area (Figure 6.20). Conservation and recreation land use accounts for 30 per cent of the catchment, all of which is in the ACT, and 20 per cent of the catchment is rural lands, mainly in NSW. For the catchment areas surrounding Lake Tuggeranong, the great majority is urbanised (Figure 6.20).

120. Beer, T., et al., 1982. *Environmental water quality: a systems study in Tuggeranong Creek and Kambah Pool*. CRES Monograph 5, Centre for Resource and Environmental Studies, Australian National University, Canberra.

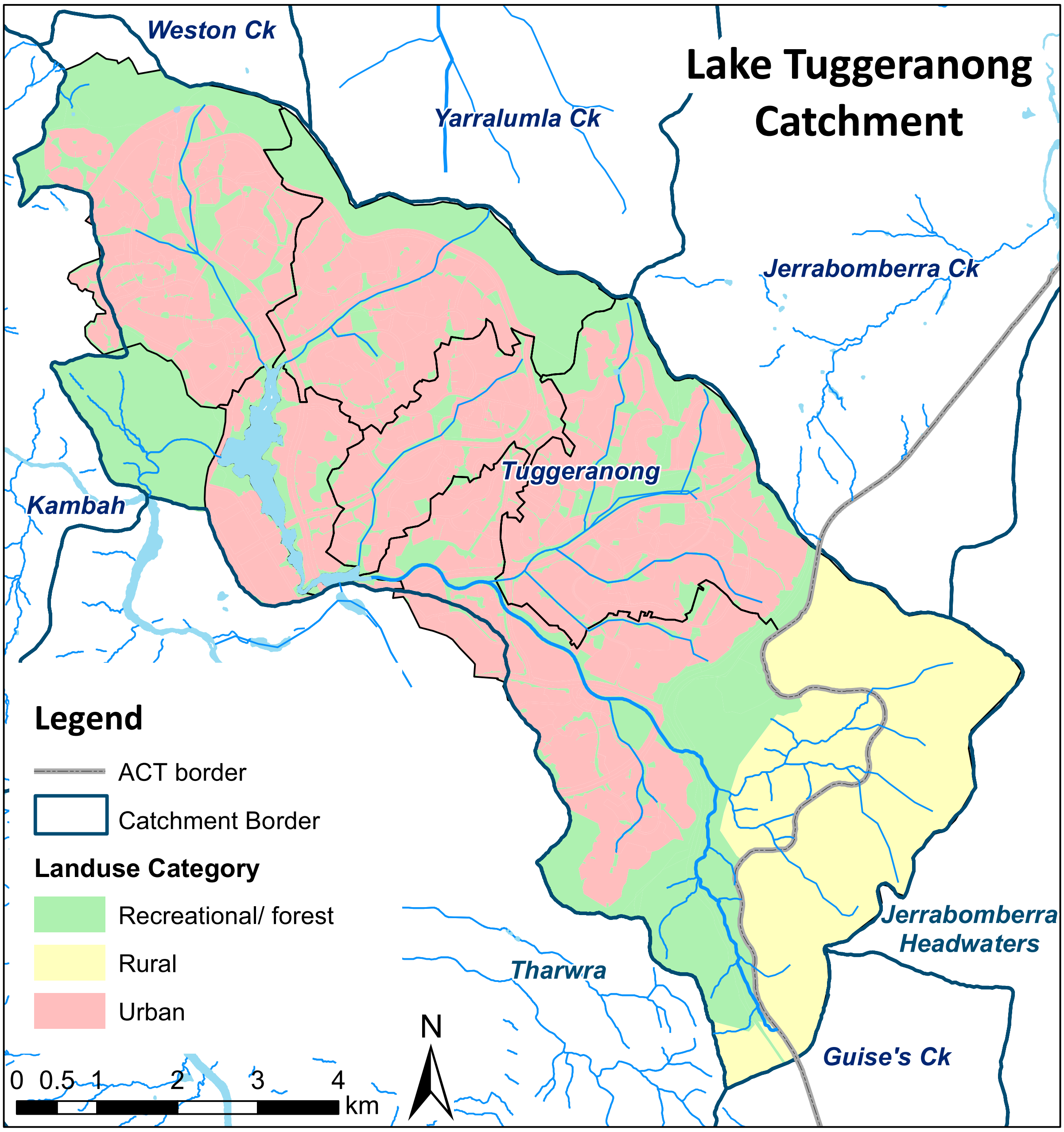



**Figure 6.20.** Lake Tuggeranong catchment and land use.

**Source:** University of Canberra Centre for Applied Water Science. Data sourced from ACT and NSW Governments.

### Hydrology

Lake Tuggeranong has a surface area of 0.57 km$^2$ with a maximum depth of 13 metres near the centre of the lake at the site of an old quarry. The lake has a capacity of 1.8 GL.

### Inflows to Lake Tuggeranong

The major inflows for Lake Tuggeranong include Tuggeranong Creek (the original channel was dammed to create the lake), Village Creek, Kambah Creek and Oxley inflow which mostly carry and discharge stormwater (Figure 6.21). A range of additional smaller urban streams and stormwater drains deliver water to the lake. All inflows to Lake Tuggeranong are ungauged, although Tuggeranong Creek has a water level recording station located at the weir.


**Figure 6.21.** Lake Tuggeranong and related waterways including main inflows.

**Data sourced from:** ACT Government

Because flow data is unavailable, it has not been possible for this Investigation to determine the volume of inflows to Lake Tuggeranong. However, it is likely that inflows are highly variable with the heavily urbanised catchment and associated impermeable surfaces generating large flow changes in response to rainfall events.

**Outflows from Lake Tuggeranong**

Outflows from Lake Tuggeranong are received by Tuggeranong Creek which then flows into the Murrumbidgee River approximately 2km downstream. Consequently, maintaining acceptable flows downstream of Lake Tuggeranong is important for the ecosystem health of both Tuggeranong Creek and the Murrumbidgee River.

Because flow data is unavailable for Lake Tuggeranong's inflows, it is not possible to determine the proportion of Lake Tuggeranong's inflows that are released downstream nor if the outflows are adequate to maintain the health of downstream waterways. However, it is assumed that during times when the lake is full, outflows are equivalent to inflows, whereas in drought periods, it is likely outflows are lower than inflows to maintain the water level in the lake.

From 2010 to 2021, flow data for Tuggeranong Creek downstream of Lake Tuggeranong shows that the average annual flow was around 11,470 megalitres per year. The maximum annual flow downstream of Lake Tuggeranong was 24,900 megalitres in 2010, and the minimum was 2,840 megalitres in 2019 during the drought.

### 6.2.4 Water quality in Lake Tuggeranong

Lake Tuggeranong has a reputation for poor water quality and regularly suffers from cyanobacterial blooms and high levels of faecal pollution. The poor water quality is often accompanied by odours, highly turbid water, and unsightly algal blooms reducing the recreational and aesthetic value of the lake and surrounds. Flora and fauna are also impacted by poor water quality in the lake.

This poor water quality is mainly the result of the heavily urbanised catchment which increases rainfall runoff and the water flowing into stormwater drains. This increased runoff transports high pollutant loads including nutrients, sediment, animal faeces, litter, and organic waste such as leaves. Improvements to the water quality of Lake Tuggeranong will depend on reducing the pollutant loads entering the lake.

#### Recreational water quality

Lake Tuggeranong's recreational water quality is monitored at three sites throughout the year. Recreational closure data are only available for Lake Tuggeranong from 2015–16. The lake is closed to recreational use if either cyanobacteria (blue-green algae) or enterococci (a faecal indicator bacteria) concentrations exceed the levels specified in the ACT recreational water guidelines.[121] Closures

121. ACT Health, 2014. *ACT Guidelines for Recreational Water Quality*. ACT Government, Canberra.

prevent community access to Lake Tuggeranong for a range of summer water activities that involve primary contact. Long closure periods have consequences for health and wellbeing. The Tuggeranong community values the lake for a range of recreational activities throughout the year, and particularly in summer to provide relief on hot days.

## Lake Tuggeranong closures

From 2015–16 to 2020–21, the lake was frequently closed over the recreational season from mid-October to mid-April. In four of those years, it was closed for more than 60 per cent of the recreational season, and in 2016–17 and 2020–21, it was closed for around 80 per cent of the recreational season (Figure 6.22). The main reason for the closures was high concentrations of cyanobacteria in the lake. Closures have also occurred in each season because of the high levels of enterococci.

The frequent recreational closures clearly demonstrate a failure to meet the community's recreational and aesthetic expectations for Lake Tuggeranong.

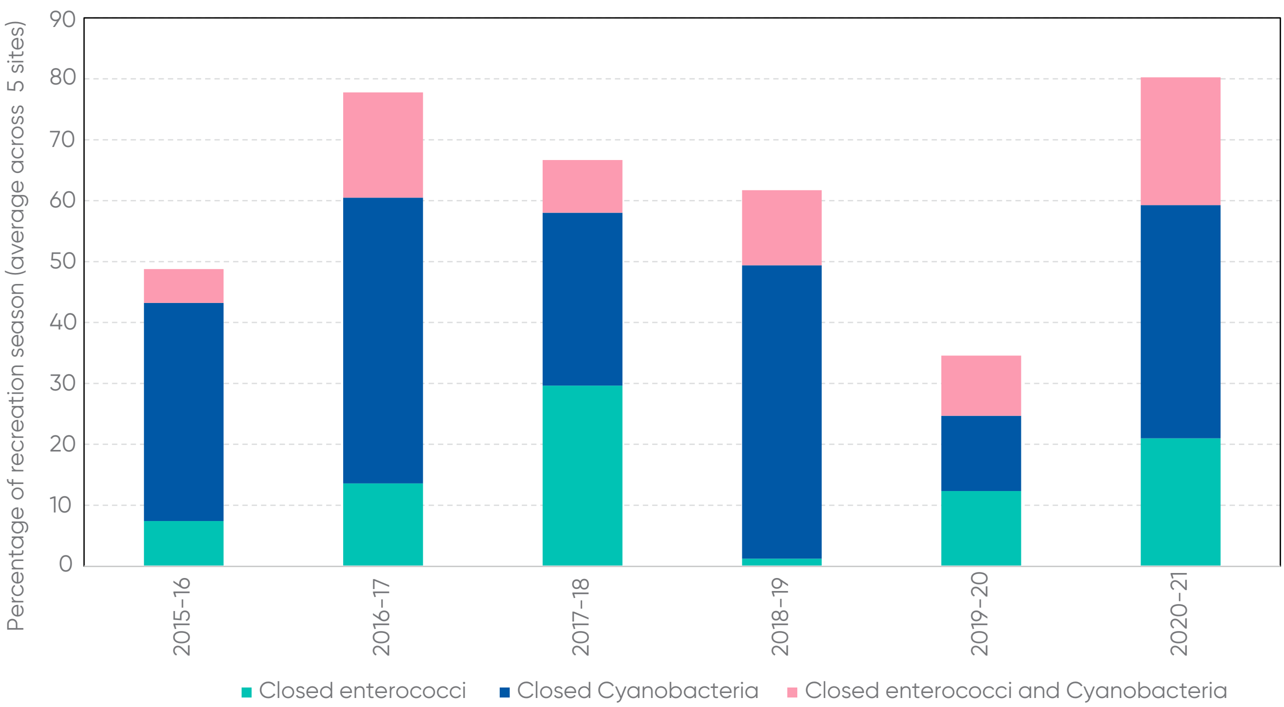



**Figure 6.22.** Proportion of the recreational season that Lake Tuggeranong was closed to recreational activities by closure reason, 2015-16 to 2020-21.

**Data sourced from:** ACT Government.

**Note:** Data show the average closures across 5 monitored sites during the recreation season (October to April).

## Levels of cyanobacteria

The concentrations of cyanobacteria in Lake Tuggeranong vary seasonally with high concentrations occurring over summer, causing the frequent lake closures (Figure 6.23). There are regular occurrences of extreme cyanobacteria concentrations with peaks from mid-summer onwards. Around 56 per cent of samples taken had low cyanobacteria concentrations, around 33 per cent had medium concentrations, 6 per cent had high concentrations and 5 per cent had extreme concentrations.

Research has shown that cyanobacterial blooms are likely driven by high concentrations of nutrients, particularly phosphorus. Weather conditions were also found to have a large influence on the abundance and composition of the cyanobacteria community. Summer conditions are conducive to cyanobacteria blooms, including warm water and strong sunlight that cause the lake to stratify into thermal layers.

Once a cyanobacterial bloom commences in Lake Tuggeranong, subsequent inflows from rainfall runoff provide the additional nutrients required to support an ongoing bloom. The availability of nutrients in the lake is also likely enhanced by the release of phosphorus from sediments, particularly in response to low dissolved oxygen levels. However, inflows from rainfall runoff are considered the predominant nutrient source to the lake.

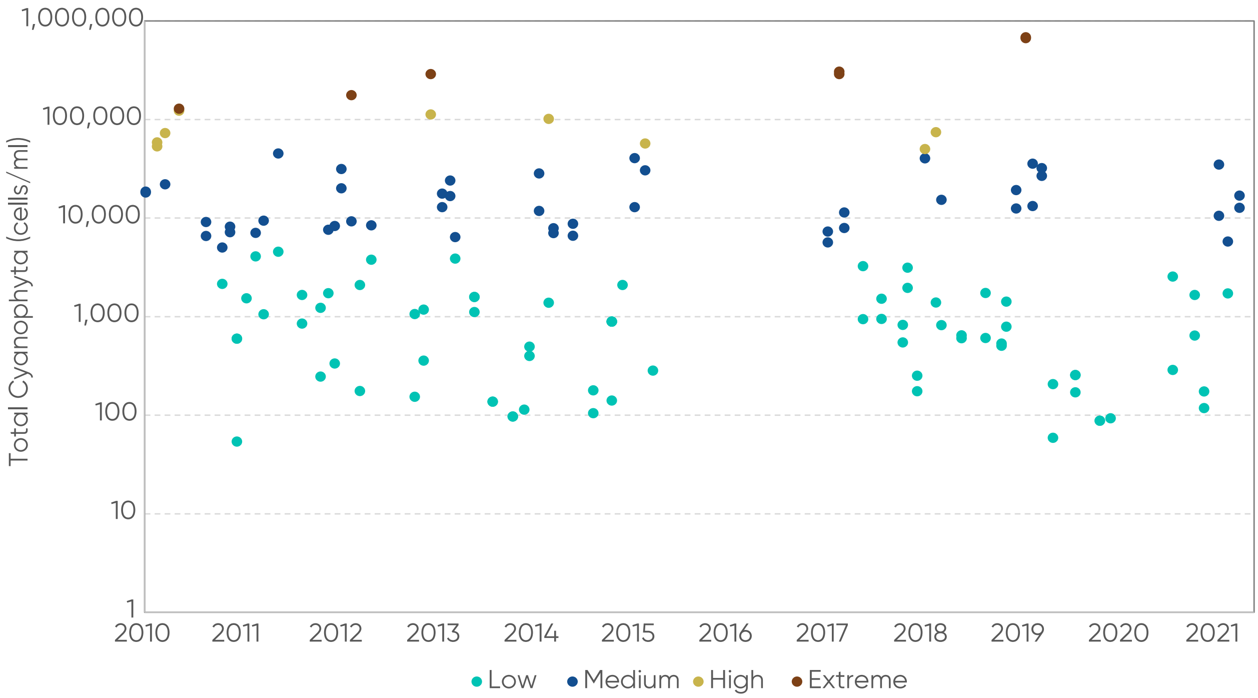



**Figure 6.23.** Cyanobacteria cell counts in Lake Tuggeranong for the period January 2010 to July 2021.

**Data sourced from:** ACT Environment Protection Authority.

**Note:** The low to extreme categories indicate cyanobacteria alert levels in the ACT Guidelines for Recreational Water Quality. Low = <5,000 algae cells/ml; Medium = ≥5,000 to <50,000 algae cells/ml; High = ≥50,000 to ≤125,000 algae cells/ml; Extreme = ≥125,000 algae cells/ml.

A comparison of cyanobacteria results between Lake Tuggeranong and Lake Burley Griffin supports the theory that algal blooms in Lake Tuggeranong are significantly driven by external nutrient sources. The peak concentrations of cyanobacteria in Lake Tuggeranong occur slightly earlier in the recreational season than in Lake Burley Griffin (see section **6.1.4 Water quality in Lake Burley Griffin**), suggesting there are different processes driving the algal blooms.[122] Whilst it is likely that algal blooms in Lake Burley Griffin may be much more driven by internal lake processes, the earlier blooms in Lake Tuggeranong suggest the high nutrient loads in urban runoff are the predominant driver, occurring at any time throughout the summer season. It is also evident that there are higher algal concentrations in Lake Tuggeranong in response to periods of increased rainfall which deliver large loads of nutrients to the lake.

These differences in algal bloom drivers between the lakes have consequences for the effectiveness of management approaches. To reduce the occurrence of algal blooms in the future, management actions will need to address the main drivers of algal blooms specific to each urban lake rather than utilising a common approach.

Climate change is predicted to further increase the occurrence of cyanobacterial blooms in Lake Tuggeranong. It is thought that lower water temperature is a key limiting factor for cyanobacterial blooms in the lake. With climate change increasing temperatures across the region, blooms in the lake may continue to increase in the future rendering it even less able to support the expected recreational functions and visual amenity.

### Prevention of algal blooms

The quality of water entering Lake Tuggeranong must be improved for there to be any reduction in the occurrence and severity of cyanobacterial blooms. Especially important is the need to make significant decreases in the lake's nutrient and sediment concentrations, as well as the organic matter entering the lake.

Trials of in-lake interventions to manage algal blooms within Lake Tuggeranong have been undertaken.[123] However, researchers concluded that although some interventions showed potential under experimental conditions (e.g. the use of PhoslockTM to limit phosphorus release from sediments, and the use of hydrogen peroxide to reduce cyanobacterial cells), in-lake treatments are not recommended until the external nutrient loads are decreased. This is because a large rainfall event occurring after any in-lake treatment would rapidly return the lake to conditions that support new cyanobacteria blooms.

Any proposed algal bloom interventions for Lake Tuggeranong need to have comprehensive assessments of their potential effectiveness as well as the environmental, social and economic impacts.

The community also has an important role in reducing the occurrence of algal blooms by helping to improve the quality of urban stormwater (see Breakout Box **Community actions for better stormwater quality** in **Chapter 10**).

122. Dyer, F., O'Connell, J. and Ubrihien, R., 2020. *Managing cyanobacteria in Lake Burley Griffin: Data review and recommendations*. A report to the National Capital Authority from the Centre for Applied Water Science. University of Canberra, Canberra.

123. Ubrihien, R., et al., 2020. *Lake Tuggeranong Research Project Report: Stage 3.* A report to the ACT Government from the Centre for Applied Water Science. University of Canberra, Canberra.

## Floating wetlands in Lake Tuggeranong

Source: ACT Government Healthy Waterways

One approach currently being tested to reduce the occurrence and severity of algal blooms in Lake Tuggeranong is the use of floating wetlands. These were installed by the ACT Government Healthy Waterways Team in 2021 and are Canberra's first largescale floating wetlands. They comprise several floating platforms and were installed in the bay where Village Creek drains into the lake. The site was selected to reduce the impacts of a nearby gross pollutant trap which was found to be releasing high nutrient loads into the lake.

*Floating wetland in the Village Creek Bay of Lake Tuggeranong, December 2021. Source: Andrew Crompton.*

It is hoped that the floating wetlands will compete with algae for nutrients and light, reducing the occurrence of blooms. Whilst the overall effectiveness of the wetlands is yet to be determined, the plantings on the platforms have thrived. Unfortunately, the platforms have been exposed to strong flows during large storms which has damaged the anchoring structures. This means they will need to be moved further into the lake where storm flows are reduced.

These floating wetlands are just one of many other innovations being explored to reduce nutrient levels in Lake Tuggeranong, including wetlands, water recycling, improving rainfall infiltration, natural cleansing of stormwater, bioretention swales, rain gardens, subsurface wetlands, and restoring cement drains to more natural channels.

## Nutrients

Nutrient concentrations in Lake Tuggeranong are regularly above the acceptable levels for urban lakes and are sufficiently high to support cyanobacterial blooms throughout the year. From 2010 to July 2021, nearly 12 per cent of the recorded phosphorus concentrations were above the acceptable range (acceptable range is less than 0.1 milligrams per litre) in the surface waters of Lake Tuggeranong (Figure 6.24). It is interesting to note that 50 per cent of samples taken in Lake Tuggeranong would exceed the phosphorus guideline levels applied to Lake Burley Griffin (0.06 milligrams per litre).

The concentration of phosphorus in the surface waters of Lake Tuggeranong are dependent on pollutant inflows and the release of nutrients from the bottom sediments. There is much variation in these processes, both within and between years. This means that it is not possible to fully understand the annual variation in phosphorus levels, nor determine any trends in phosphorus changes over time.

For nitrogen, around 80 per cent of the recorded concentrations have been above the acceptable range, with some notable high concentrations evident (Figure 6.25).[124]

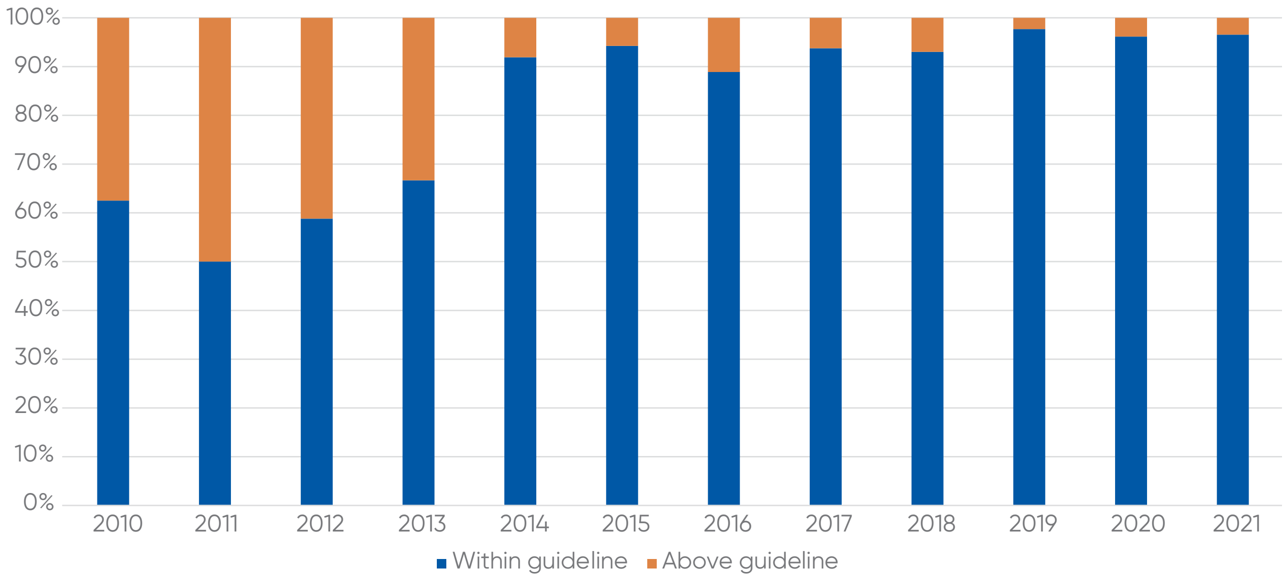



**Figure 6.24.** Percentage of total phosphorus concentrations within guideline levels in the surface waters of Lake Tuggeranong, 2010 to July 2021.

**Data sourced from:** Data are combined from Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

124. Nutrient assessments do not include Waterwatch data prior to 2014 because of a change in sampling kits. This means that available data is not well suited to long term analyses because data from different sources are required.

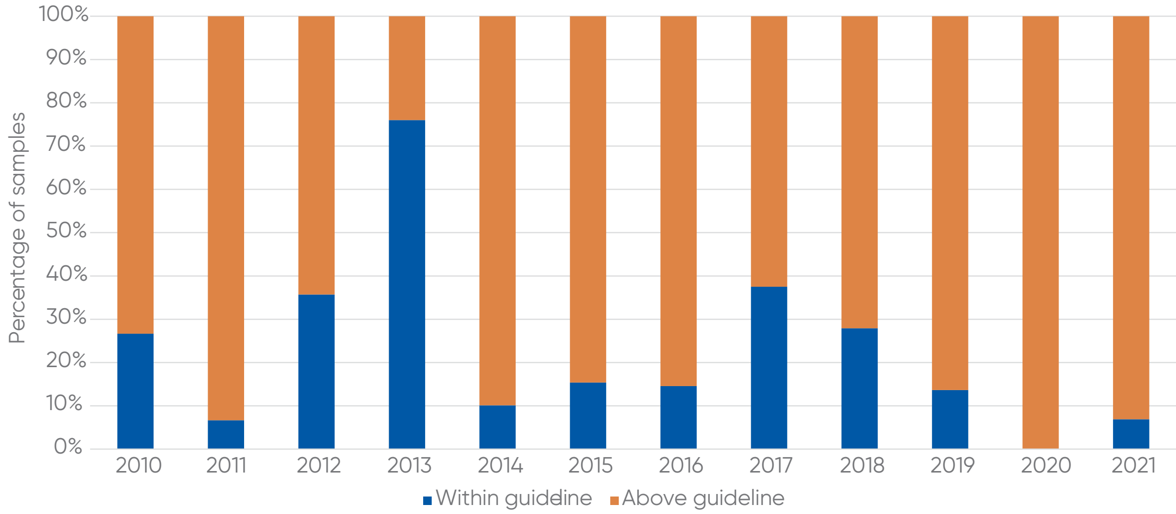



**Figure 6.25.** Percentage of total nitrogen concentrations within guideline levels in the surface waters of Lake Tuggeranong, 2010 to July 2021.

**Data sourced from:** Data are combined from Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

The concentrations of phosphorus reported here are comparable with nutrient research undertaken for Lake Tuggeranong from 2017 to 2019. This research suggested that concentrations of phosphorus observed in the surface waters of Lake Tuggeranong were more than three times the concentrations at which cyanobacteria are likely to be the dominant phytoplankton present and susceptible to bloom conditions.[125]

In comparison, results for nitrogen reported for this Investigation are much higher than the nutrient research undertaken for Lake Tuggeranong between 2017 and 2019.[126] This may indicate that the Waterwatch and ACT Government Lakes and Rivers Water Quality Monitoring Program nitrogen data used for this Investigation may be overestimating the nitrogen concentrations. However, this cannot be determined without further analysis of nitrogen results to determine the accuracy of current monitoring programs.

Annual average phosphorus and nitrogen concentrations in the surface waters of Lake Tuggeranong were reasonably consistent from 2014 to 2021 (Figure 6.26 and Figure 6.27). Phosphorus annual averages were below the acceptable range for all years except for 2010 and 2011. However, monitoring results show concentrations do exceed the acceptable range in Lake Tuggeranong on many occasions. All of the annual averages for phosphorus were above the concentration required to limit the formation of cyanobacterial blooms. Again, it should be noted that it is currently not possible to fully understand the annual variation in phosphorus levels in Lake Tuggeranong, nor determine any trends in phosphorus changes over time.

Annual averages for nitrogen were well above the acceptable range for all years except 2013.

125. Ubrihien, R., et al., 2020. *Lake Tuggeranong Research Project Report: Stage 3.* A report to the ACT Government from the Centre for Applied Water Science. University of Canberra, Canberra.

126. Ibid.

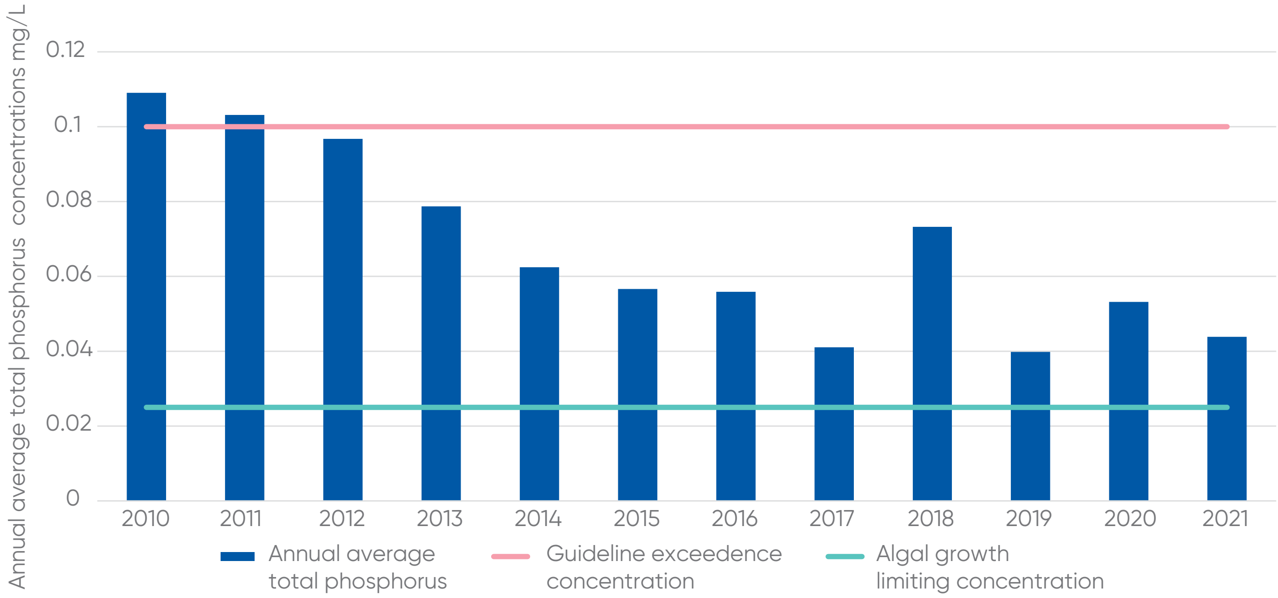



**Figure 6.26.** Annual average total phosphorus concentrations in the surface waters of Lake Tuggeranong, 2010 to July 2021. The pink line shows the maximum acceptable concentration for total phosphorus as specified in the Environment Protection Regulation 2005. The teal line shows the concentration under which phosphorus levels are expected to limit the formation of cyanobacterial blooms.

**Data sourced from:** Data are averages of Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

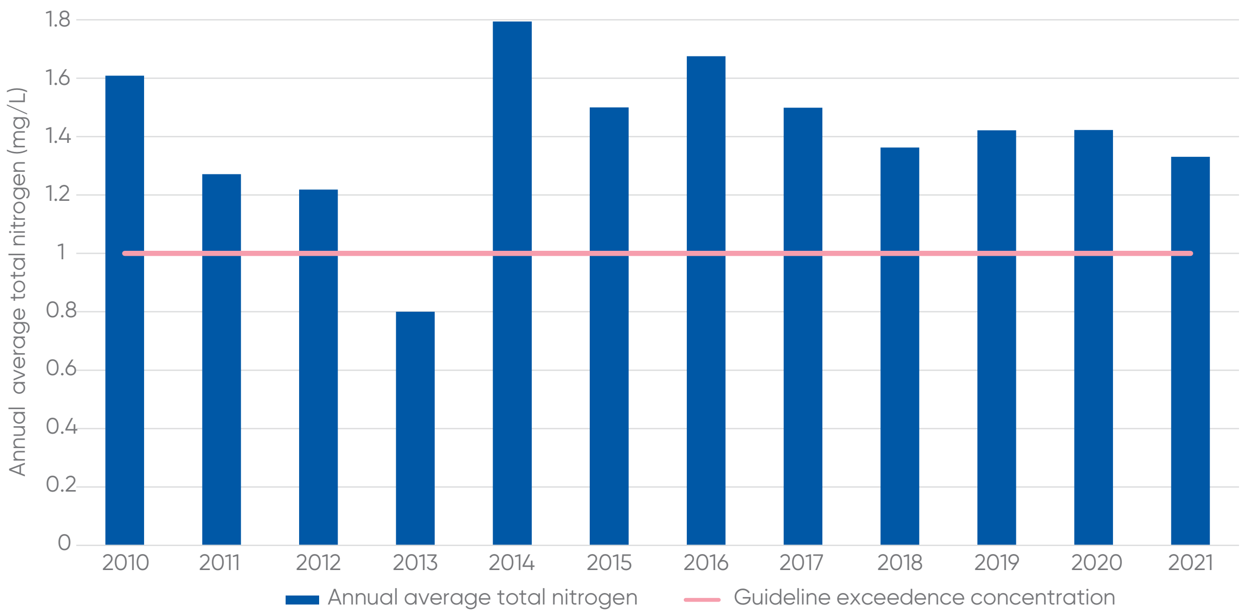



**Figure 6.27.** Annual average total nitrogen concentrations in the surface waters of Lake Tuggeranong, 2010 to July 2021. The pink line shows the maximum acceptable concentration for total nitrogen as specified in the Environment Protection Regulation 2005.

**Data sourced from:** Data are averages of Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

## Nutrient sources and management

The main source of nutrients in Lake Tuggeranong are inflows of rainfall runoff from the urban catchment which deposit fertilisers, sediments, animal faeces and organic debris such as leaves and grass clippings into the lake. Lake sediments and organic matter (internal lake nutrient sources) are also contributing significant amounts of nutrients. However, an accurate determination of nutrient sources requires a much better understanding of the main catchment inflows and the pollutant loads they transport during rainfall events. This can only be obtained through improved event-based monitoring.

Key to reducing nutrient pollution is improving the effectiveness of urban runoff interception and pollutant removal. Nutrient reductions in lake inflows will also help to offset the releases of nutrients from lake sediments, and decrease the concentration of nutrients and amount of organic matter stored in lake sediments over time.

Any achievements in nutrient reduction will likely require further additions to the current water sensitive urban design infrastructure, as well as improving the performance of existing infrastructure. It should be noted that interventions to improve water quality are likely to take many years, particularly for measures to reduce nutrient concentrations.

The community also has an important role in reducing nutrient pollution by helping to improve the quality of urban stormwater (see Breakout Box **Community actions for better stormwater quality** in **Chapter 10**).

Nutrient research undertaken for Lake Tuggeranong from 2017 to 2019 provides the most recent estimates of nutrient sources to the lake.[127] Main findings include:

- There was considerable variability in annual nutrient loads to the lake, with significant increases during rainfall events.
- Both external and internal nutrient sources are contributing significant amounts of nutrients to the lake with nutrient releases from sediments during low dissolved oxygen conditions contributing 20 per cent of the lake's total nutrients.
- Almost half of the phosphorus flowing into the lake during rainfall events was in a dissolved form which is immediately available to support algal growth leading to greater risk of cyanobacterial blooms.
- Runoff from sporting fields contributes higher concentrations of nutrients than other land uses in the Lake Tuggeranong catchments.
- Intermittent point source contamination events were detected that contribute very high concentrations of nutrients to the lake.
- Under baseflow conditions Village Creek and Wanniassa stormwater catchment typically have the highest nutrient concentrations.
- Water sensitive urban design infrastructure at the bottom of the Wanniassa stormwater catchment reduces nutrient concentrations prior to entry to the lake, making it less of a concern under baseflow conditions than Village Creek.

127. Ibid.

The researchers also suggested management actions to reduce nutrient inputs, including:[128]

- The lower part of Village Creek below the playing fields should be a priority for further pollution control infrastructure. This is because the Village Creek catchment mainly comprises underground pipes so there is little opportunity for nutrient reduction upstream of the lower reaches.
- Priority should be given to reducing the amount of nutrients entering the lake during storm events, particularly from Kambah Creek.
- To limit the input of nutrients from playing fields to the lake, the application of fertiliser and watering of playing fields should be reviewed. In addition, for the design and redevelopment of stormwater systems, consideration of nutrient inputs from playing fields should be considered.
- Because of the high proportions of impervious surfaces in the Lake Tuggeranong catchment, along with stormwater networks that predominantly consist of concrete channels and pipes, any interventions that allow infiltration, reduce flow rates and increase water retention in the catchments will assist in reducing the high nutrient inputs to the lake.
- The water sensitive urban design projects undertaken as part of the ACT Healthy Waterways project in the catchments are likely to be beneficial, however, further work is required to decrease nutrient loads during high flow events.

Another study undertaken on Lake Tuggeranong, as part of the ACT Healthy Waterways Program, focussed on the efficacy of gross pollutant traps (GPTs).[129] It found that GPTs had benefits for Lake Tuggeranong, improving visual amenity, and protecting recreational opportunities and downstream assets. However, the GPTs were not considered as a priority option for improving water quality and reducing algal bloom frequency in Lake Tuggeranong. This is because they provide only moderate reductions in nutrient loading and algal community reduction (<10% in all cases). Consequently, other water sensitive urban design measures need to be prioritised to improve water quality. The efficacy of GPTs at Lake Tuggeranong could be improved by increasing the frequency of dredging and the introduction of macrophytes within or surrounding the traps to provide some biological treatment of the nutrient loads sourced from the surrounding catchments.

128. Ibid.

129. HydroNumerics, 2016. *Lake Tuggeranong suspended sediments modelling*: A report to the ACT Government. HydroNumeric Pty Ltd, Carlton.

## Turbidity

Although turbidity levels were generally within, or close to, water quality guidelines, around 22 per cent of records were above the acceptable range for ACT lakes (Figure 6.28) and there were periods of turbidity well above the acceptable range, including 400 **NTU**[130] recorded in April 2014.

Annual average turbidity was higher than the acceptable range for three years from 2010 to 2021 and was particularly high in 2018 and 2019 (Figure 6.29). Reasons for high average annual turbidity are unclear but were likely in response to periods of high turbidity caused by heavy rainfall or pollution events.

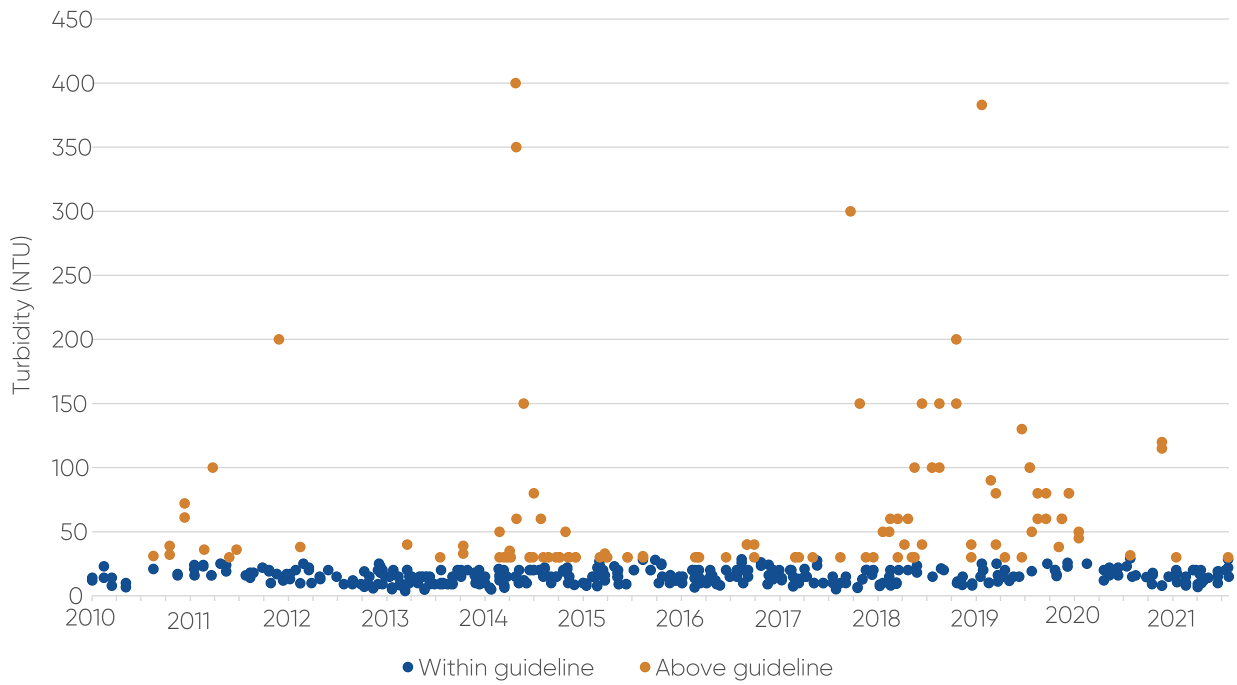



**Figure 6.28.** Turbidity samples within and above guideline levels in the surface waters of Lake Tuggeranong, 2010 to July 2021.

**Data sourced from:** Data are combined from Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

**Note:** Samples of 30 NTU and above exceed the turbidity guideline as stated in the Environment Protection Regulation 2005.

130. NTU stands for Nephelometric Turbidity unit. It is a measure of water clarity based on the amount of light scattered by particles in the water column. Particles can be organic such as algal cells, and inorganic such as fine sediment. Water with a high NTU has elevated concentrations of suspended particles and often looks dirty. The water can appear brown or green, as well as other colours, dependent on the type of suspended particles.

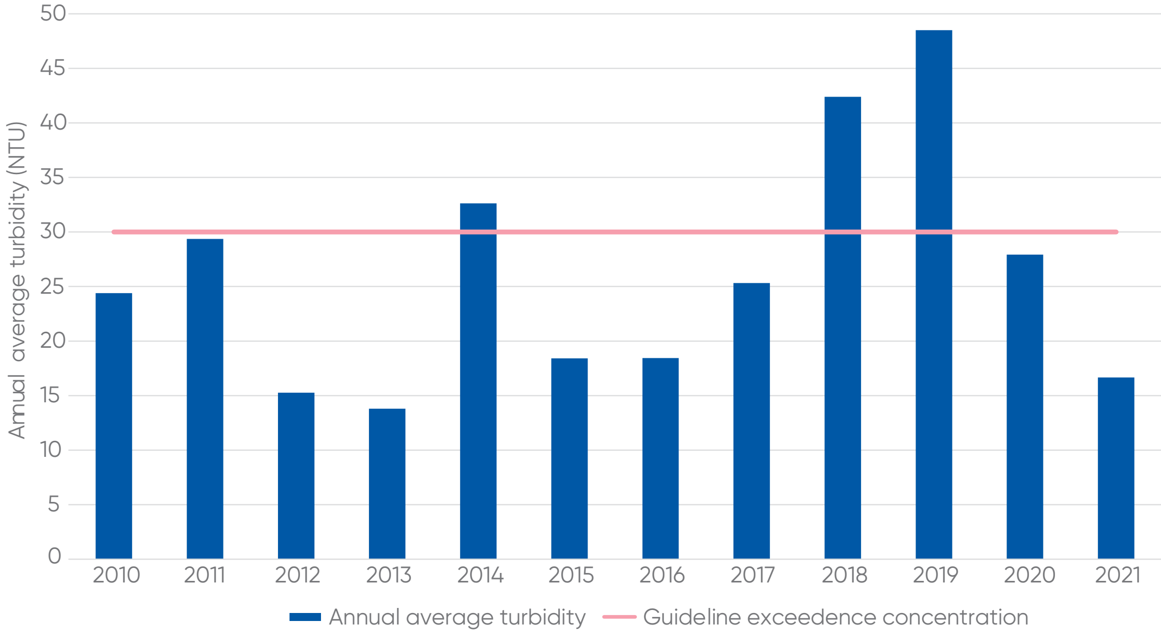



**Figure 6.29.** Annual average turbidity in the surface waters of Lake Tuggeranong, 2010 to July 2021. The pink line shows the maximum acceptable concentration for turbidity as specified in the Environment Protection Regulation 2005.

**Data sourced from:** Data are averages of Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

## Dissolved oxygen, pH, and conductivity

Other water quality parameters monitored in the surface waters of Lake Tuggeranong include dissolved oxygen, pH, and electrical conductivity (a measure of salt concentration). All these parameters were found to be generally within the acceptable range to support aquatic ecosystems over the 2010 to July 2021 period. Monitoring results for lake surface waters showed that:

- pH was consistently within the acceptable range with only 4 per cent of readings above the upper pH limit of 8.5 and 1 per cent of data below a pH of 6.
- Dissolved oxygen concentrations were generally well above the acceptable range with only 5 per cent of readings below acceptable levels of 4mg/L. Concentrations in the bottom waters were lower and were consistent with those of lakes that stratify over summer.
- Conductivity was almost always within the acceptable range with extremely rare instances of values exceeding ACT lake guidelines.

## Maintaining downstream water quality

One of the key functions of Lake Tuggeranong is to improve the quality of water flowing from the Tuggeranong suburbs into the Murrumbidgee River. This is achieved as sediment, nutrients and other pollutants settle in the slow flowing waters of the lake. Water quality improvements between upstream and downstream lake areas are not only dependent on the type of pollutant but also on a range of conditions including rainfall, inflow volumes, temperature and wind.

Results for water quality upstream, within and downstream of Lake Tuggeranong from 2014 to July 2021 show that the lake does not appear to be effectively mitigating some of the effects of urbanisation for the downstream receiving waters. This is evidenced by periods of higher phosphorus concentrations within the lake and in the downstream Tuggeranong Creek compared to upstream of the lake (Figure 6.30). That said, phosphorous concentrations downstream of the lake were lower than in-lake levels for five years from 2014 to July 2021, which may indicate the lake is mitigating phosphorus pollution at times.

With the exception of 2020 and 2021, in-lake and downstream nitrogen (as nitrate) concentrations were higher than the upstream Tuggeranong Creek site (Figure 6.31). Higher nitrogen concentrations were also found for the downstream site compared to in-lake levels for five of the eight years reported. These findings suggest Lake Tuggeranong is not effective at mitigating nitrogen pollution.

It should be noted that concentrations of nutrients from the Tuggeranong Creek inflows were lower than most other inflows to Lake Tuggeranong.[131] This makes upstream to downstream comparisons difficult because long term data is only available for Tuggeranong Creek. Given that other inflows to Lake Tuggeranong have higher nutrient concentrations, it may be that the lake is somewhat mitigating the impact of the pollutant inflows to downstream waters.

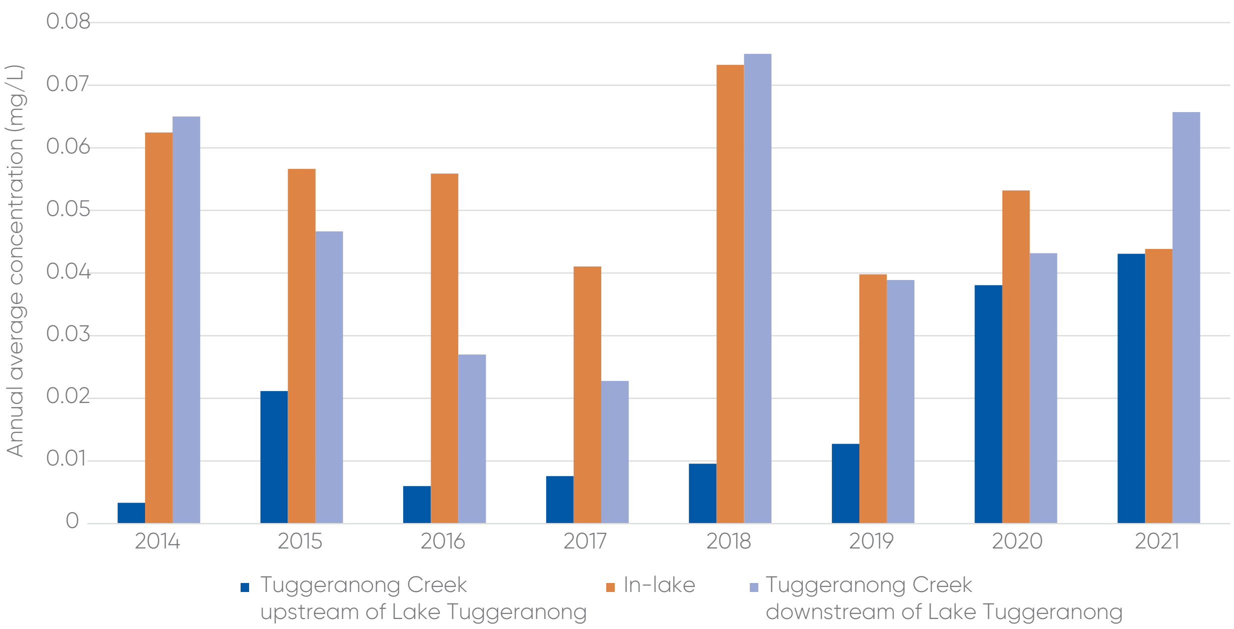



**Figure 6.30.** Annual average total phosphorus concentrations for Tuggeranong Creek upstream and downstream of Lake Tuggeranong, and in lake surface waters, 2014 to July 2021.

**Data sourced from:** Data are combined from Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

**Note:** Data are averages for each calendar year.

131. Ubrihien, R., et al., 2020. *Lake Tuggeranong Research Project Report: Stage 3*. A report to the ACT Government from the Centre for Applied Water Science. University of Canberra, Canberra.

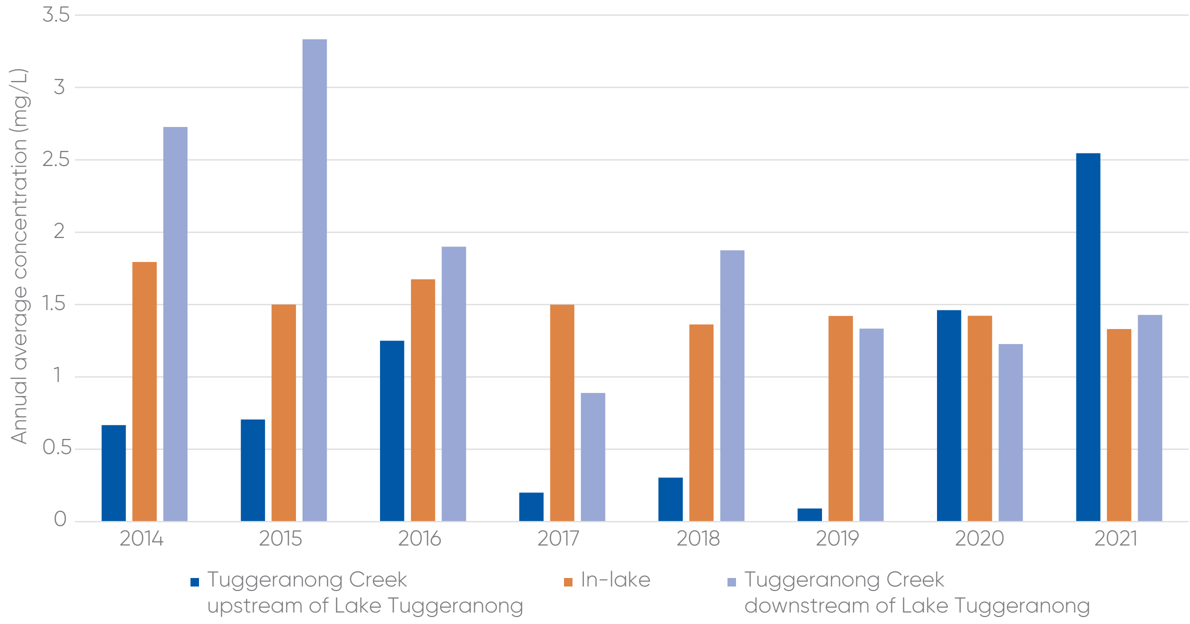



**Figure 6.31.** Annual average nitrate concentrations for Tuggeranong Creek upstream and downstream of Lake Tuggeranong, and in lake surface waters, 2014 to July 2021.

**Data sourced from:** Data are combined from Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

**Note:** Data are averages for each calendar year.

Annual turbidity levels for upstream, downstream and in-lake were found to be highly variable (Figure 6.32). Despite this, downstream turbidity was lower than in-lake levels for all but one year, suggesting that Lake Tuggeranong is mitigating turbidity pollution in most years. Turbidity in the lake is sometimes greater than that recorded in the upstream and downstream sites in Tuggeranong Creek. This is likely the result of monitoring being undertaken in Tuggeranong Creek during low flows when the water is generally clear.

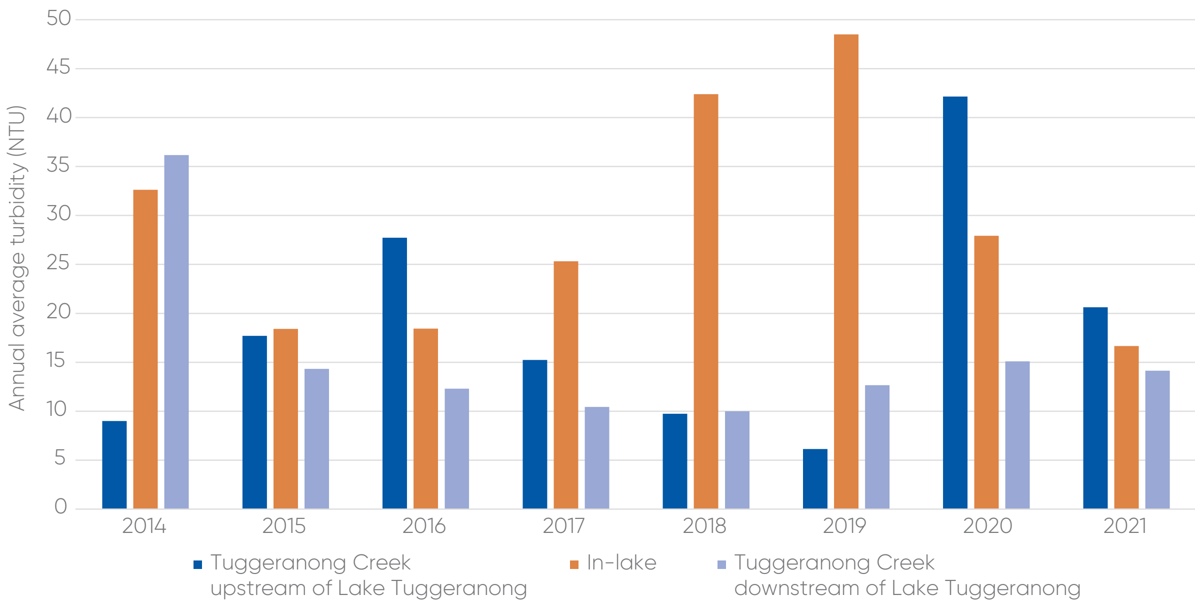



**Figure 6.32.** Annual average turbidity for Tuggeranong Creek upstream and downstream of Lake Tuggeranong, and in lake surface waters, 2014 to July 2021.

**Data sourced from:** Data are combined from Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

**Note:** Data are averages for each calendar year.

The limitations of routine monitoring data are not well suited to evaluating the water quality mitigation performance of Lake Tuggeranong. Improved inflow and pollutant load data are required to accurately assess the performance of the lake, particularly as the majority of nutrients and suspended sediments are transported to the lake under high flow conditions. It is also worth noting that since Lake Tuggeranong was designed and constructed, the extent of urban development in the catchment has significantly increased. This may mean that the lake is unable to improve downstream water quality without further interventions to improve water quality.

## Biodiversity and ecosystem health of Lake Tuggeranong

There are little data available that would allow trends in the broader ecological values of Lake Tuggeranong to be determined.

Waterwatch provides the only systematic and regular evaluation of Lake Tuggeranong's ecological condition based on water quality, macroinvertebrates and riparian condition measured at four sites around the lake.[132] Results from the evaluations are published in the annual Catchment Health Indicator Program reports (CHIP). The past three CHIP reports (2018 to 2020) have provided an overall assessment for Lake Tuggeranong as being in fair condition (C rating), although macroinvertebrate communities were assessed as poor.

The Rapid Assessment of Riparian Condition undertaken by Waterwatch for Lake Tuggeranong assesses the riparian zone as poor to degraded with low scores for habitat, cover and nativeness of the vegetation. However, for the urban parkland environments that surround the lake, the riparian assessment methodology used by Waterwatch will likely give low scores and is perhaps not a suitable approach. In such highly managed environments, a set of clear expectations needs to be developed to better understand the condition of vegetation on the lakeshore.

## Fish

Regular stocking has seen nearly 670,000 native fish stocked to selected Canberra waters from 2011–12 to 2020–21. For Lake Tuggeranong, this includes the stocking of around 36,700 Murray Cod, and 34,400 Golden Perch.[133] These account for 10 per cent of these species stocked to Canberra's urban waters. In addition to stocked fish, self-sustaining populations of Western Carp Gudgeon are also known to be present in Lake Tuggeranong.

Fish populations in Lake Tuggeranong are surveyed every two to three years by the ACT Government. Results show that the water quality and ecosystem health of the lake are sufficient for the survival of stocked native fish, with no evidence of high mortality rates.

132. O'Reilly, et al., 2021. *Catchment Health Indicator Program: Report Card 2020*. Upper Murrumbidgee Waterwatch, Canberra.
133. Environment and Planning Directorate, 2015. *Fish Stocking Plan for the Australian Capital Territory 2015–2020*. ACT Government, Canberra.

There have been no native fish kills in Lake Tuggeranong. The only fish kill occurred in the weir pool in January 2020 which resulted in the death of more than 50 carp. Whilst the loss of invasive carp is not problematic, the cause was likely low dissolved oxygen concentrations. This shows that the weir pool experiences periods of low dissolved oxygen in response to inflows of pollutants and weather conditions.

Lake Tuggeranong supports self-sustaining populations of European Carp and Redfin Perch, both invasive species that have negative effects on water quality and other fish species.

### 6.2.5 Knowledge gaps for Lake Tuggeranong

This Investigation has found the following key knowledge gaps for Lake Tuggeranong:

- To understand the source and volume of pollutants entering the lake, more frequent monitoring needs to occur, including events-based monitoring that assesses periods of high pollutant loads during rainfall events.
- The major cause of cyanobacteria blooms in Lake Tuggeranong is the inflow of nutrients from the catchment during rainfall runoff. However, while it appears that nutrients are entering stormwater from across all suburbs and that playing fields are an important source, there is currently no comprehensive information on the nutrient sources for the lake. An improved understanding of the main nutrient sources, particularly during high rainfall events, is required to improve the management of nutrients and to reduce the frequency of cyanobacterial blooms.
- There are considerable logistical challenges in determining inflows to Lake Tuggeranong. Limited flow data are available with water levels monitored for Tuggeranong Weir but not for Village Creek, the lake's other major inflow. In addition, the complex stormwater piping combined with overland flows makes it difficult and expensive to determine inflows. Accurate flow data is not only required to measure the pollutant loads entering the lake but is also key to designing interventions to reduce external nutrient loads to Lake Tuggeranong.
- The combination of poor inflow data (for both pollutants and flows) and the lack of information on pollutants downstream of the lake, means it is not possible to evaluate the effectiveness of Lake Tuggeranong at trapping pollutants. This remains an important gap in our understanding of the lake and its current performance in maintaining downstream water quality and preventing impacts on the Murrumbidgee River.

For information on improving water quality and ecosystem health information see section **11.8 Effectiveness of monitoring, evaluation and reporting processes for urban waters**.

*People at Lake Tuggeranong. Source: Miranda Gardner*

# 6.3 Lake Ginninderra



*Urban development at Lake Ginninderra*

*Source: Ryan Colley*

### 6.3.1 Lake Ginninderra main findings and key actions

#### Condition assessment against management and community values

The values used to assess the state of Lake Ginninderra are based on selected key requirements for the quality of water as outlined in the Canberra Urban Lakes and Ponds Land Management Plan.[134] This includes assessing whether the water quality and aquatic health of Lake Ginninderra support recreational, aesthetic and ecological values, and whether Lake Ginninderra maintains downstream water quality and flow.[135] The assessments are informed by the data findings discussed in section **6.3.3 Data Trends for Lake Ginninderra**.

134. Environment, Planning and Sustainable Development Directorate, 2022. *Canberra Urban Lakes and Ponds Land Management Plan*. ACT Government, Canberra.

135. Recreational activities include primary contact such as swimming.

| Value | Status | Condition | Trend | Data quality |
|---|---|---|---|---|
| **LG1:** Does the water quality in Lake Ginninderra support recreational and aesthetic values? | Lake Ginninderra is typically closed for less than 40 per cent of the recreational season, except in 2016–17 and 2017–18 when it was closed for around 60 per cent of the recreational season. High enterococci concentrations have been responsible for most of the closures, occurring in every season since 2015–16. The cyanobacteria species Microcystis, which is common in the other urban lakes, has become more prevalent in Lake Ginninderra. This may indicate changes in the lake's pollutant loads because of increasing urban development in the catchment. This change raises concerns about future water quality | Fair | ↓ | ●●● High |
| **LG2:** Does the aquatic health of Lake Ginninderra support ecological values? | There is little comprehensive long-term information on the ecological values of the lake to provide an assessment with a high level of confidence. Current knowledge is limited to Waterwatch assessments undertaken from 2018 to 2020, which determined the lake's macroinvertebrate communities to be in fair condition, although riparian condition was assessed as poor. There is no current information or long-term data on macrophyte extent and condition in Lake Ginninderra. Most of the lake margins has fringing reedbeds which is indicative of a better ecological condition. It is considered that the water quality and ecosystem health of the lake are sufficient for the survival of stocked native fish, with no evidence of high mortality rates. | Fair | ? | ●●● Moderate |
| **LG3:** Does Lake Ginninderra maintain downstream water quality and flow? | **Water quality**<br>Lake Ginninderra does not appear to be effectively mitigating the effects of urbanisation for the downstream receiving waters. This is evidenced by higher phosphorus concentrations downstream of the lake in most years, and occasional higher downstream nitrogen concentrations. However, downstream turbidity levels were lower suggesting that the lake is mitigating turbidity issues. Confidence in this assessment is low because of data limitations. It may be that the lake is protecting downstream water quality, but this remains uncertain without improved data. | Fair | ? | ●●● Moderate |
| | **Flow**<br>Although there is a lack of accurate upstream to downstream flow data, it is considered that flow releases from the lake are adequate to maintain the health of downstream waterways. | Good | ? | ●●● Moderate |

## Indicator assessment legend

### Condition

- **Good** = Environmental condition is healthy OR pressure likely to have negligible impact on environmental condition/human health/waterbody values.
- **Fair** = Environmental condition is neither positive or negative OR pressure likely to have limited impact on environmental condition/human health/waterbody values.
- **Poor** = Environmental condition is under significant stress, OR pressure likely to have significant impact on environmental condition/human health/waterbody values.
- **Unknown** = Data is insufficient to make an assessment of status and trends.

### Trend

- ↑ Improving
- ↓ Deteriorating
- \- Stable
- ? Unclear

### Data quality

- ●●● **High** = Adequate high-quality evidence and high level of consensus
- ●●● **Moderate** = Limited evidence or limited consensus
- ●●● **Low** = Evidence and consensus too low to make an assessment

## Lake Ginninderra main findings

**Inflows and outflows 2011 to 2021**

- The only gauging station upstream of the lake is located on Ginninderra Creek near the Barton Highway. Flow at this site is highly variable with an average annual flow of 13,035 megalitres, a high flow of 35,168 megalitres in 2021 and a low flow of 3,552 megalitres in 2019 during the severe drought period.
- The lake receives urban stormwater discharges from the surrounding southern and eastern suburbs of Belconnen, including the Belconnen Town Centre. Inflows from these are ungauged.
- The nearest flow gauging station downstream of the lake is some 7km from the outlet, located on Ginninderra Creek at Charnwood Road near Jarramlee. Consequently, it is not possible to accurately compare flows upstream and downstream of Lake Ginninderra because of the urban stormwater inputs between the lake and the downstream gauging station.
- A comparison of annual flows in Ginninderra Creek upstream and downstream of the lake shows that downstream flows are generally higher, sometimes significantly so, but this is because of the additional stormwater inflows between the lake and the gauging station.
- The only year when flows upstream of Lake Ginninderra exceeded those downstream was in 2017, likely because of the need to raise lake levels after a period of low rainfall.
- Although there is a lack of accurate upstream to downstream flow data, it appears that water releases from the lake are adequate to maintain the health of downstream waterways.

**Water quality**

- Unlike Lake Tuggeranong, Lake Ginninderra has not had a history of significant water quality issues that have led to extensive lake closures.
- The current lake water quality issues are confined to rare cyanobacterial blooms and regular high enterococci concentrations, with all other water quality parameters typically within the acceptable range.
- The main pressure on the lake's water quality is the significant inflow of pollutants from urban areas which account for 50 per cent of the catchment. Urban development is continuing in the catchment, which will likely further degrade water quality in the absence of effective pollution controls.

**Recreational water quality 2015–16 to 2020–21**

- Lake Ginninderra is typically closed for less than 40 per cent of the recreational season, with exceptions in 2016–17 and 2017–18 when it was closed for around 60 per cent of the recreational season.
- High enterococci concentrations have been responsible for most of the Lake Ginninderra recreational season closures, occurring in every season since 2015–16. This contrasts with recreational closures for Lake Tuggeranong and Lake Burley Griffin (since 2017–18) which are often caused by high cyanobacteria concentrations.

- The 2016–17 and 2017–18 recreational seasons were the only years where cyanobacteria had a significant impact on recreation usage, causing the same number of closures as enterococci.
- It is thought that the recreational water quality results for Lake Ginninderra may be influenced by the location of sampling sites. Some of the sampling sites are known to be key congregation points for ducks and other waterbirds which may be causing high enterococci levels.
- The most effective approach to improving recreational water quality is to reduce the levels of nutrients, sediment, and organic matter entering the lake, as well as the animal faeces that accompany such pollutants during high rainfall events. The Belconnen community has an important role in preventing such pollution.

**Levels of cyanobacteria 2010 to July 2021**

- Cyanobacterial concentrations in Lake Ginninderra are generally low but vary seasonally with medium levels sometimes recorded in late summer and into autumn.
- Around 88 per cent of the samples taken had low cyanobacteria concentrations, around 11 per cent had medium concentrations. Concentrations of cyanobacteria cells classed as high are rare with occurrences limited to 2017.
- Microcystis species have become more common in Lake Ginninderra. This may indicate changes in the lake's pollutant loads because of increasing urban development in the catchment. This change raises concerns about future water quality.
- The drivers of Lake Ginninderra algal blooms are unclear with phosphorus concentrations within guideline levels from 2010 to April 2021.
- This may mean that the current guideline standards for nutrient levels is too high to prevent algal blooms.

**Nutrients 2010 to April 2021**

- There was only one recorded phosphorus concentration which exceeded guideline levels.
- Nearly 80 per cent of phosphorus records were below 0.025 milligrams per litre — a concentration thought to limit the growth of cyanobacteria growth. This may be the reason for the lower incidence of algal blooms in Lake Ginninderra compared with Lake Tuggeranong.
- Protection of these low phosphorus concentrations in Lake Ginninderra is vital to prevent any increases in cyanobacterial blooms.
- Of the recorded nitrogen concentrations, 28 per cent were above guideline levels.
- Average annual concentrations of phosphorus and nitrogen in the surface waters of Lake Ginninderra were below guideline levels with the exception of 2010 for nitrogen.
- The main source of nutrients in Lake Ginninderra are most likely inflows of rainfall runoff from the urban catchment which deposit large loads of pollutants into the lake.
- An accurate determination of nutrient sources for Lake Ginninderra requires a much better understanding of the main catchment inflows and the pollutant loads they transport during rainfall events. This can only be obtained through improved events-based monitoring.

- Lake sediments and organic matter (internal lake nutrient sources) may also be contributing to nutrients in the lake but research is required to determine if this is happening.

**Other water quality parameters 2010 to April 2021**

- Dissolved oxygen, pH and conductivity (salinity) were all found to be mostly within the acceptable range to support aquatic ecosystems.
- Only 4 per cent of turbidity records were above the acceptable range for ACT lakes. This is likely in response to periods of high turbidity caused by heavy rainfall or pollution events.

**Maintaining downstream water quality**

- From 2014 to 2021, phosphorus was higher at the downstream Ginninderra Creek monitoring site compared to upstream of the lake in most years, and nitrogen concentrations were occasionally higher.
- Turbidity levels downstream of Lake Ginninderra were lower for most years from 2011 to 2021. In-lake turbidity was also found to be lower in most years compared to both upstream and downstream levels. This suggests that the lake is mitigating turbidity issues.
- Overall, Lake Ginninderra does not appear to be effectively mitigating the effects of urbanisation for the downstream receiving waters. However, results presented here are influenced by the data limitations (including the lack of data on stormwater inflows, and monitoring biased toward low flows), and so it may well be that Lake Ginninderra is somewhat mitigating the impact of the pollutant inflows to the lake.

**Biodiversity and ecosystem health**

- There are little data available that would allow trends in the broader ecological values of Lake Ginninderra to be determined.
- Waterwatch provides the only systematic and regular evaluation of Lake Ginninderra's ecological condition. The past three assessments undertaken from 2018 to 2020, have found the lake to be in fair condition, with macroinvertebrate communities also classed as fair.
- Waterwatch assessments have found Lake Ginninderra's riparian zone to be in poor condition. However, for the urban parkland environments that surround the lake, the riparian assessment methodology used by Waterwatch is perhaps not a suitable approach. In such highly managed environments, a set of clear expectations needs to be developed to better understand the condition of vegetation on the lakeshore.
- There is no current information or long-term data on macrophyte extent and condition in Lake Ginninderra. Most of the lake margins has fringing reedbeds which is in contrast to Lake Tuggeranong and Lake Burley Griffin. Their presence is indicative of a better ecological condition.
- The lake and surrounds support a range of birds including the crested shrike-tit, white winged triller, superb parrots and regent honeyeater, as well as the Rakali, turtles, frogs and macro-invertebrates.

- Regular stocking has seen around 95,300 Murray Cod and 72,100 Golden Perch released to the lake from 2011–12 to 2020–21. This accounts for around 30 per cent of the Murray Cod and 20 per cent of the Golden Perch stocked to Canberra's urban waters.
- The water quality and ecosystem health of the lake are sufficient for the survival of stocked native fish, with no evidence of high mortality rates.
- Lake Ginninderra supports self-sustaining populations of European Carp and Redfin Perch, both introduced species that have negative effects on water quality and other fish species.

### Lake Ginninderra key actions

That the ACT Government:

**Key Action 6.14:** Identify management actions required to maintain the water quality in Lake Ginninderra, particularly in response to pressures from the ongoing urban expansion in the catchment. This will require the identification of water quality issues and the priority actions needed to prevent increased water pollution.

**Key Action 6.15:** Analyse catchment pollutant sources and loads for Lake Ginninderra. Analysis should include all main inflows, estimates for periods of high and low lake inflows, and for both dissolved and particulate forms of nutrients.

**Key Action 6.16:** Improve flow data for the main catchment inflows to Lake Ginninderra to enable assessments of pollutant loads and the effectiveness of water quality management.

**Key Action 6.17:** Investigate whether the recreational water quality results for Lake Ginninderra are being influenced by the location of sampling sites with regard to the presence of waterbirds which may be causing high enterococci levels.

## 6.3.2 Pressures on the aquatic health of Lake Ginninderra

This section discusses pressures that are specific to Lake Ginninderra. For general water quality and aquatic health pressures see sections **5.1 Impacts on Canberra's urban lakes and waterways** and **5.2 Monitoring water quality and pollutants**.

Urban development continues to grow in the lake's catchment, including high density urban infill. This is a significant pressure on Lake Ginninderra's water quality and aquatic health, generating higher levels of pollutants that flow into the lake via Ginninderra Creek and stormwater drains. This increases the burden on existing water sensitive urban design infrastructure constructed to manage pollutant loads from urban runoff. The increased pollution may require new pollution control infrastructure or improved performance from existing controls.

### 6.3.3 Data trends for Lake Ginninderra

## Lake Ginninderra catchment and hydrology

**Catchment**

Lake Ginninderra drains a catchment of approximately 98 $km^2$. The catchment area is dominated by urban (47%) and conservation/recreation (53%) land uses (Figure 6.33). Rural lands account for less than 1 per cent of the catchment area.

**Hydrology**

Lake Ginninderra has a surface area of around 1.05 $km^2$ and an average depth of 3.5 metres. The lake holds some 3,700 megalitres of water when full.

**Inflows to Lake Ginninderra**

Ginninderra Creek provides the main inflows to Lake Ginninderra. Urban stormwater discharges from the surrounding southern and eastern suburbs of Belconnen, including the Belconnen Town Centre, also contribute to inflows (Figure 6.34). There are limited flow data available to evaluate the contributions from the various inflows.

The only gauging station upstream of the lake is located on Ginninderra Creek near the Barton Highway. Flow data for the period 2011 to 2021 shows an average annual flow of 13,035 megalitres, a high flow of 35,168 megalitres in 2021, and a low flow of 3,552 megalitres in 2019 during the severe drought.[136]

**Outflows from Lake Ginninderra**

Maintaining acceptable flows downstream of Lake Ginninderra is important for the ecosystem health of Ginninderra Creek and the Murrumbidgee River.

The nearest flow gauging station downstream of the lake is some 7 km from the outlet, located on Ginninderra Creek at Charnwood Road near Jarramlee. It should be noted that because of the position of this flow gauging station, it is not possible to accurately compare flows upstream and downstream of Lake Ginninderra. This is because of the urban stormwater inputs to Ginninderra Creek between the lake and the gauging station. However, comparisons can show periods where flows downstream of Lake Ginninderra have been severely reduced in comparison to lake inflows.

136. Sourced from the Bureau of Meteorology.

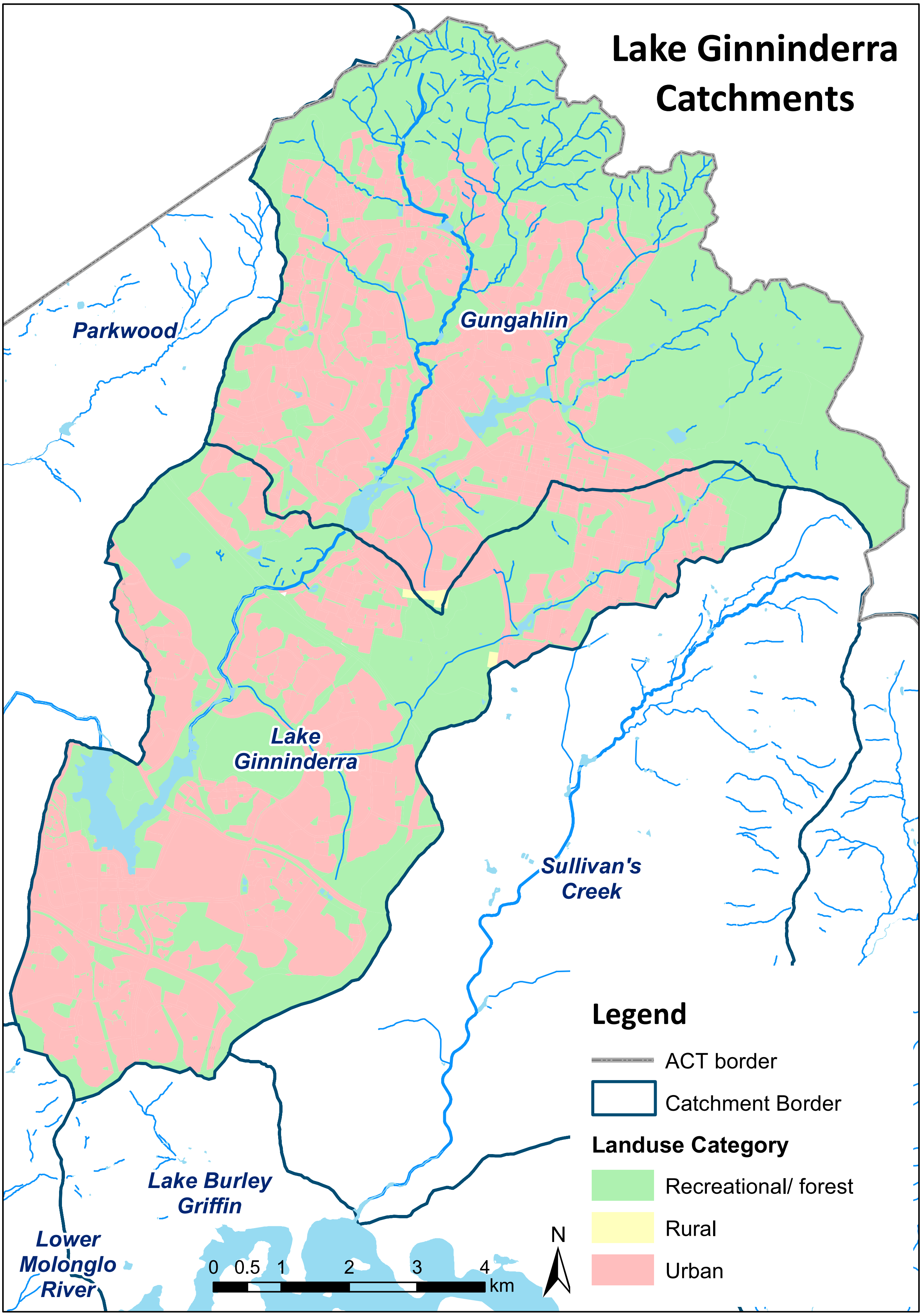



**Figure 6.33.** Lake Ginninderra catchment and distribution of land use categories.

**Source:** University of Canberra, Centre for Applied Water Science. Data from ACT Government.

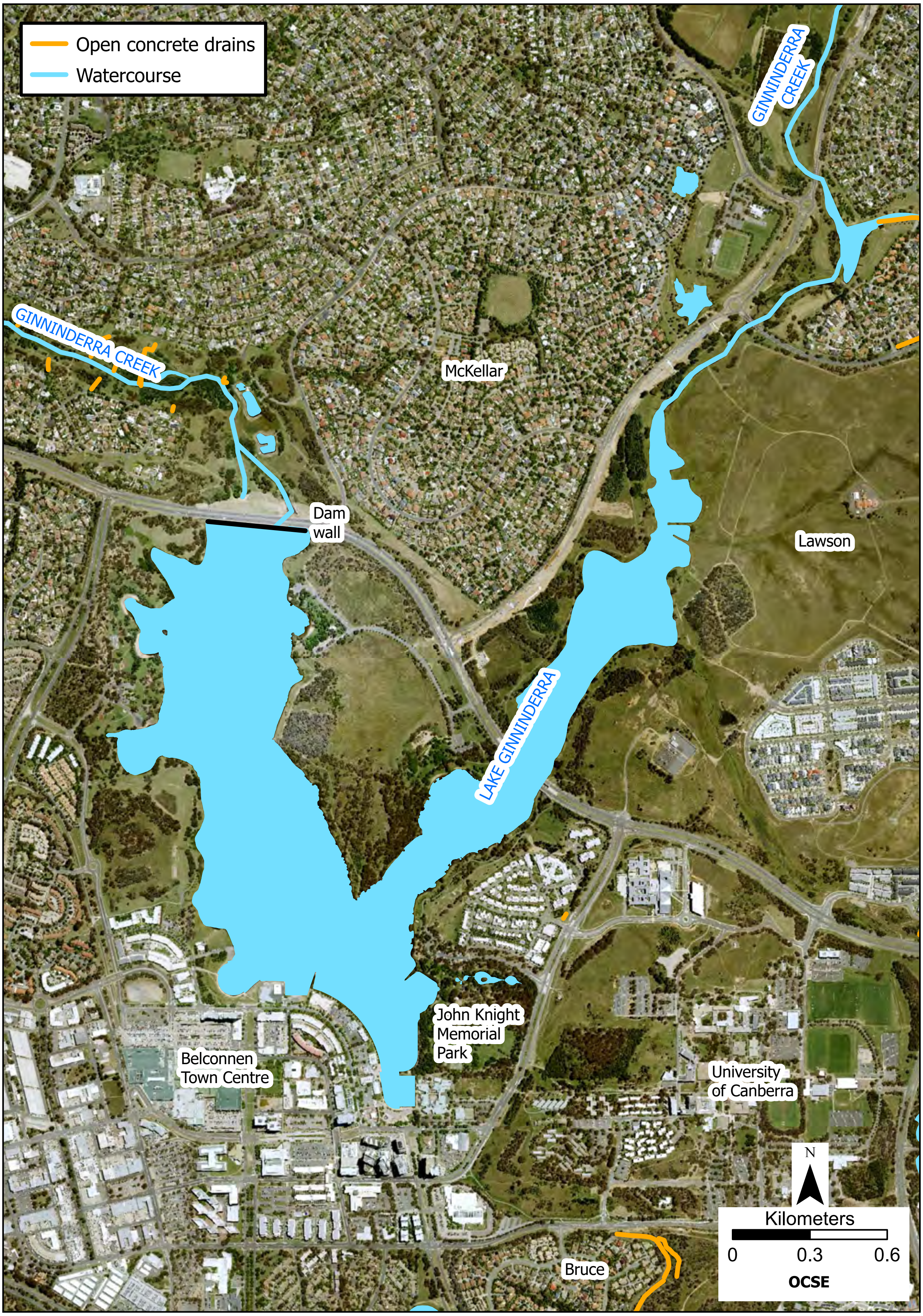



**Figure 6.34.** Lake Ginninderra and related waterways including main inflows

**Data sourced from:** ACT Government

For the period 2011 to 2021, the average annual flow in Ginninderra Creek downstream of Lake Ginninderra was 19,878 megalitres, with a highest flow of 38,825 megalitres in 2021 and a lowest flow of 5,610 megalitres in 2019 during the severe drought.[137]

A comparison of annual flows in Ginninderra Creek upstream and downstream of the lake shows that downstream flows are generally higher, sometimes significantly so (Figure 6.35). These higher flows downstream of the lake are because of the additional stormwater inputs from the surrounding urban areas. The only year when flows upstream of Lake Ginninderra exceeded those downstream was 2017. The reason for this is unclear but is likely because of the need to raise lake levels after a period of low rainfall.

Given the higher flows downstream of Lake Ginninderra in most years, it appears that flow releases from the lake are adequate to maintain the health of downstream waterways.

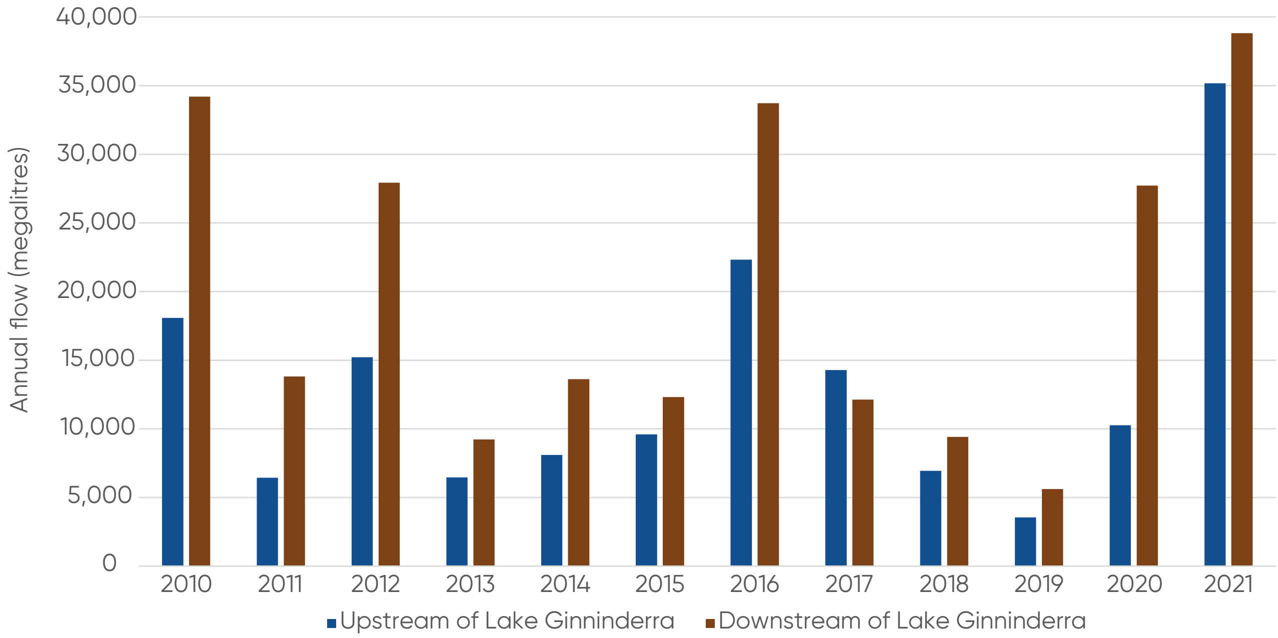



**Figure 6.35.** Annual flow discharges in Ginninderra Creek upstream and downstream of Lake Ginninderra, 2010 to 2021.

**Data sourced from:** Bureau of Meteorology

**Note:** The downstream Ginninderra Creek site is situated 7 km from the lake outlet and receives additional urban stormwater discharges. This does not allow for an accurate comparison of flows upstream and downstream of Lake Ginninderra.

137. Ibid.

### 6.3.4 Water quality in Lake Ginninderra

Unlike Lake Tuggeranong, Lake Ginninderra has not had a history of significant water quality issues that have led to extensive lake closures. The current lake water quality issues that affect recreation and the aesthetic values of the lake are confined to rare cyanobacterial blooms and regular high enterococci concentrations, with all other water quality parameters typically within the acceptable range.

#### Recreational water quality

Recreation water quality is only available from 2015–16 for Lake Ginninderra. Recreational water quality is monitored at four sites throughout the year and the lake closed to recreational use if either cyanobacteria (blue-green algae) or enterococci (a faecal indicator bacteria) concentrations exceed the levels specified in the ACT recreational water guidelines.[138] Closures prevent community access to Lake Ginninderra for a range of summer water activities that involve primary contact. Closure periods can have consequences for health and wellbeing, particularly because Canberrans value the urban lakes for summer activities and to provide relief on hot days.

#### Lake Ginninderra closures

Between the summer seasons of 2015–16 and 2020–21, Lake Ginninderra was typically closed to recreation for less than 40 per cent of the recreational season, with exceptions in 2016–17 and 2017–18 when it was closed for around 60 per cent of the recreational season (Figure 6.36).

High enterococci concentrations have been responsible for most of Lake Ginninderra's recreational season closures, occurring in every season since 2015–16. This contrasts with recreational closures for Lake Tuggeranong and Lake Burley Griffin (since 2017–18) which are often caused by high cyanobacteria concentrations. The 2016–17 and 2017–18 seasons were the only years where cyanobacteria had a significant impact on recreational usage, causing the same number of closures as enterococci (around 30% of the total closures). It is not clear why there were high levels of cyanobacteria in these years.

It is thought that the recreational water quality results for Lake Ginninderra may be influenced by the location of sampling sites. Some of the sampling sites are known to be key congregation points for ducks and other waterbirds which may be causing high enterococci levels. This requires further investigation.

138. ACT Health, 2014. *ACT Guidelines for Recreational Water Quality*. ACT Government, Canberra.

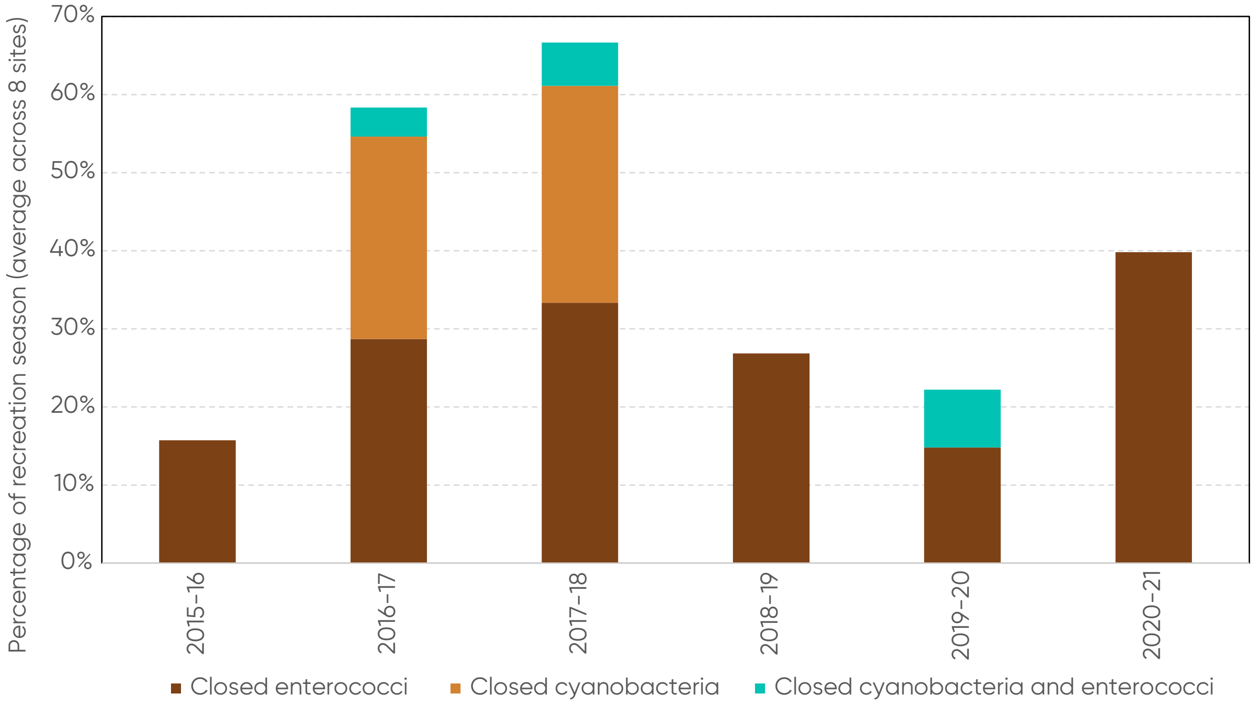



**Figure 6.36.** Proportion of the recreational season that Lake Ginninderra was closed to recreational activities by closure reason, 2015–16 to 2020–21.

**Data sourced from:** ACT Government.

**Note:** Data show the average closures across four monitored sites during the recreation season (October to April).

## Levels of cyanobacteria

Cyanobacterial cell counts recorded from 2010 to July 2021 show that most concentrations in Lake Ginninderra are generally low, but they do vary seasonally with medium levels sometimes recorded in late summer and into autumn (Figure 6.37).[139] Around 88 per cent of the samples taken had low cyanobacteria concentrations, around 11 per cent had medium concentrations. Concentrations of cyanobacteria cells classed as high are rare with occurrences limited to 2017.

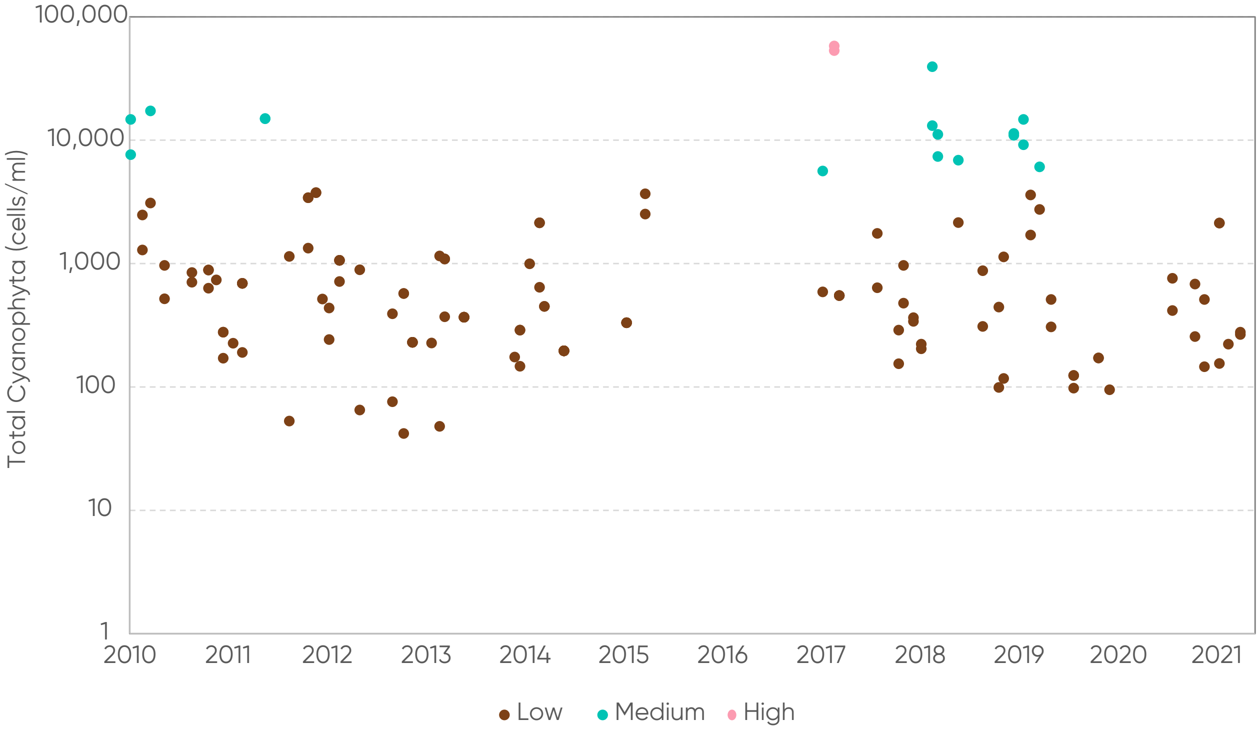



**Figure 6.37.** Cyanobacteria cell counts in Lake Ginninderra for the period January 2010 to July 2021.

**Data sourced from:** the Environment Protection Authority.

**Note:** The low to extreme categories indicate cyanobacteria alert levels in the ACT Guidelines for Recreational Water Quality.

Low = <5,000 algae cells/ml; Medium = ≥5,000 to <50,000 algae cells/ml; High = ≥50,000 to ≤125,000 algae cells/ml; Extreme = ≥125,000 algae cells/ml.

## Algal changes

The recent urban expansion in the headwaters of Ginninderra Creek may mean that there are additional pressures on Lake Ginninderra leading to algal changes. Until recently Lake Ginninderra's cyanobacterial community was dominated by Aphanocapsa species whereas Lake Burley Griffin and Lake Tuggeranong are dominated by Dolichospermum and Microcystis species. The reason for the differences is not clear. It has been attributed to less urbanisation within the catchment of Lake Ginninderra compared to other lakes or possibly because of potentially different water chemistry.

Current monitoring shows that Microcystis species have become more common in Lake Ginninderra. This may indicate changes in the lake's pollutant loads because of increasing urban development in the lake catchment. These algal changes raise concerns about future water quality.

139. Based on alert level categories in ACT Health, 2014. *ACT Guidelines for Recreational Water Quality.* ACT Government, Canberra.

## Prevention of Lake Ginninderra recreational closures

The drivers of Lake Ginninderra closures are unclear. Phosphorus concentrations in the lake were almost always within guideline levels from 2010 to April 2021, as were many other water quality variables, except for nitrogen. This may mean that the current guideline standards for phosphorus levels is too high to prevent algal blooms. The source of high enterococci levels is also unclear and requires further study given that water birds may be contributing to high bacteria counts in recreational water sampling areas.

With the many uncertainties around drivers for Lake Ginninderra closures, it is clear that the most effective approach to improving recreational water quality is to reduce the loads of pollutants entering the lake. This requires improvements in the effectiveness of urban runoff interception and pollutant removal to reduce the levels of nutrients, sediment and organic matter entering the lake, as well as the animal faeces that accompany such pollutants during high rainfall events. This will likely require additions to the current water sensitive urban design infrastructure, as well as improving the performance of existing infrastructure. It should be noted that water quality improvements are likely to take many years, particularly for measures to reduce nutrient concentrations.

The community also has an important role in reducing recreational closures by helping to improve the quality of urban stormwater (see **Chapter 10** Breakout Box **Community actions for better stormwater quality**).

## Nutrients

From 2010 to April 2021, there was only one recorded phosphorus concentration which exceeded guideline levels. For nitrogen, 28 per cent of recorded concentrations were above guideline levels, with high levels recorded in all years (Figure 6.38).

Only 23 per cent of phosphorus records have been above 0.025 milligrams per litre. Concentrations below 0.025 milligrams per litre are thought to limit the growth of cyanobacteria and this is likely to be the reason for the lower incidence of algal blooms in Lake Ginninderra compared with Lake Tuggeranong.

Average annual concentrations of phosphorus and nitrogen in the surface waters of Lake Ginninderra were below guideline levels with the exception of 2010 for nitrogen (Figure 6.39 and Figure 6.40). Again notably, the concentrations of phosphorus were generally below the levels at which algal blooms are expected to occur. Protection of these low phosphorus concentrations in Lake Ginninderra is vital to prevent any increases in cyanobacterial blooms.

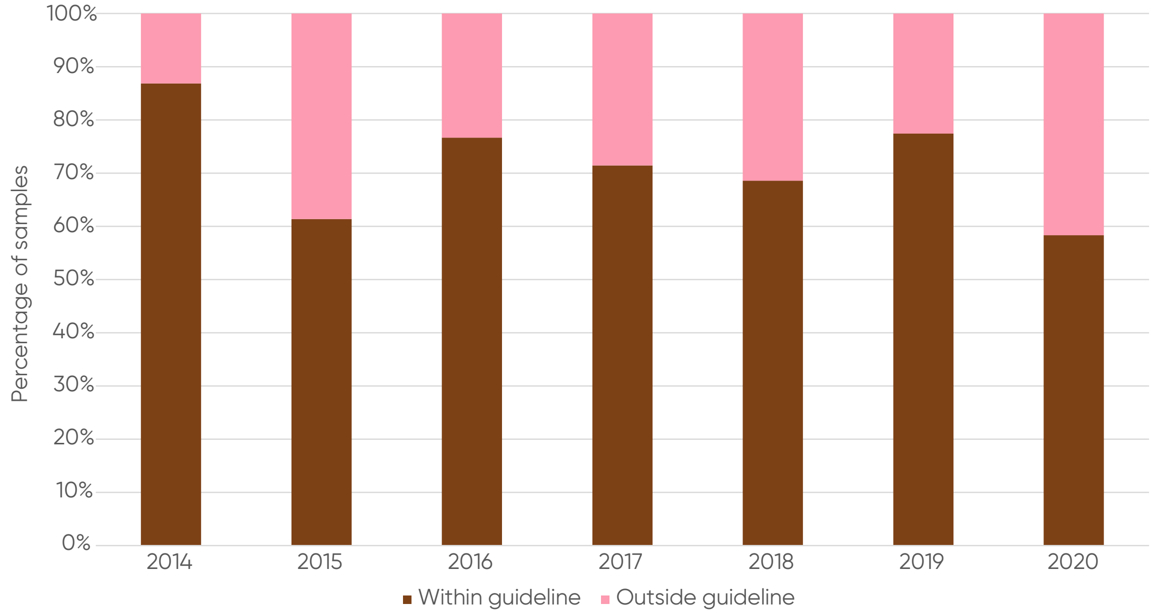



**Figure 6.38.** Percentage of total nitrogen concentrations within guideline levels in the surface waters of Lake Ginninderra, 2014 to 2020.

**Data sourced from:** Data are combined from Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

**Note:** The years 2010 to 2013, and 2021 have been excluded from this graph because of low sample numbers, however, 8 of the 30 samples taken in these years were above guideline levels.

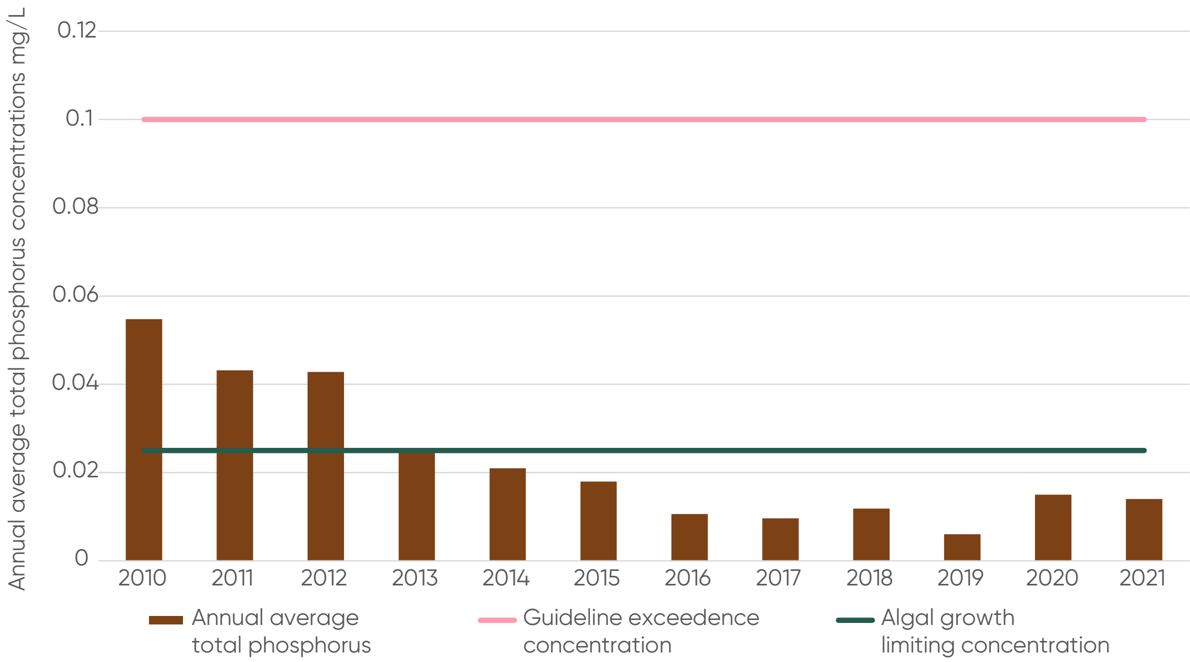



**Figure 6.39.** Annual average total phosphorus concentrations in the surface waters of Lake Ginninderra, 2010 to April 2021. The pink line shows the maximum acceptable concentration for total phosphorus as specified in the Environment Protection Regulation 2005. The green line shows the concentration under which phosphorus levels are expected to limit the formation of cyanobacterial blooms.

**Data sourced from:** Data are averages of Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

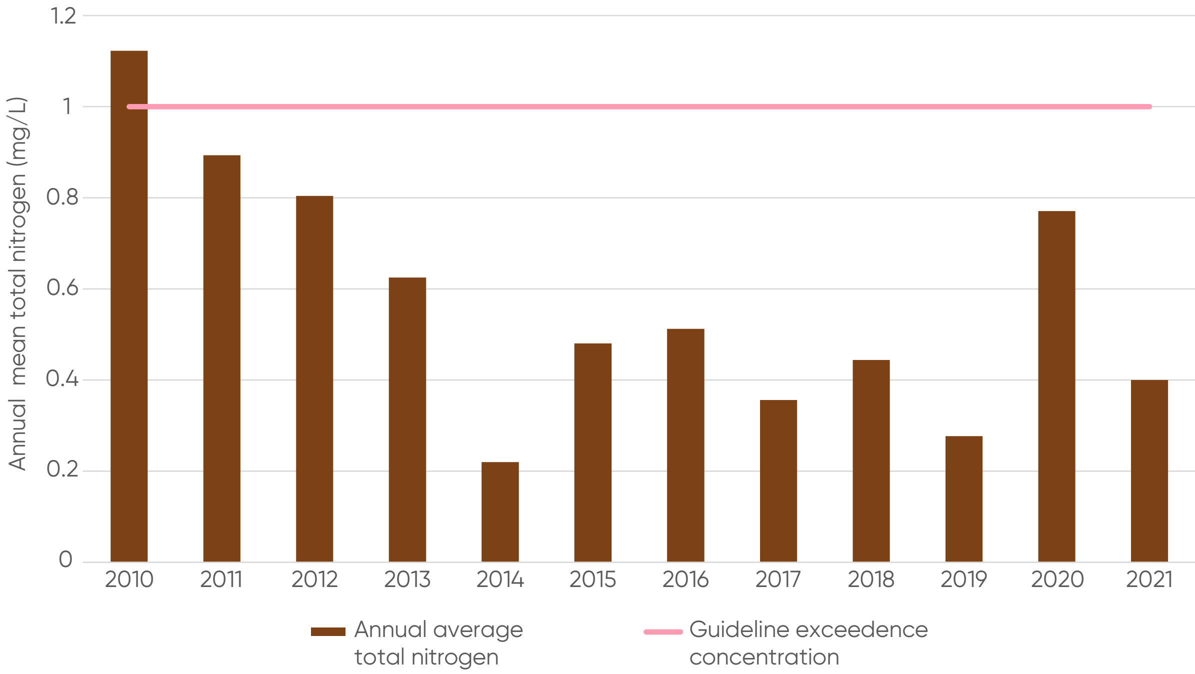



**Figure 6.40.** Annual average total nitrogen concentrations in the surface waters of Lake Ginninderra, 2010 to April 2021. The pink line shows the maximum acceptable concentration for total nitrogen as specified in the Environment Protection Regulation 2005.

**Data sourced from:** Data are averages of Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

## Sources of nutrients

The main source of nutrients in Lake Ginninderra are most likely similar to Lake Tuggeranong. This includes inflows of rainfall runoff from the urban catchment which deposit fertilisers, sediments, animal faeces and organic debris such as leaves and grass clippings into the lake.

However, an accurate determination of nutrient sources for Lake Ginninderra requires a much better understanding of the main catchment inflows and the pollutant loads they transport during rainfall events. This can only be obtained through improved events-based monitoring. Lake sediments and organic matter (internal lake nutrient sources) may also be contributing to nutrients in the lake, but research is required to determine if this is happening.

## Turbidity, pH, dissolved oxygen, and conductivity

Other water quality parameters monitored in the surface waters of Lake Ginninderra include turbidity, pH, dissolved oxygen and electrical conductivity (a measure of salt concentration). All these parameters were found to be mostly within the acceptable range to support aquatic ecosystems over the 2010 to April 2021 period. Monitoring results for lake surface waters showed that:

- Turbidity levels were generally within water quality guidelines with only 8 per cent of samples above the acceptable range for ACT lakes. With the exception of 2010, the average annual turbidity levels were consistently within the acceptable range. Reasons for high average annual turbidity in 2010 are unclear but is likely in response to high sedimentation from urban development, heavy rainfall or pollution events.

- pH was consistently within the acceptable range with only one record above the upper pH limit of 8.5.
- Less than 1 per cent of the recorded dissolved oxygen concentrations were below acceptable levels. Concentrations in the bottom waters were consistent with those of lakes that stratify over summer.
- Conductivity was consistently within the acceptable range although there were infrequent instances of samples exceeding guideline levels. Some quite high conductivity values were recorded in 2020 but it is not clear what may have caused this.

## Maintaining downstream water quality

One of the key functions of Lake Ginninderra is to improve the quality of water flowing to downstream sections of Ginninderra Creek and the Murrumbidgee River. This is achieved as sediment, nutrients and other pollutants settle in the slow flowing waters of the lake. Water quality improvements between upstream and downstream lake areas are dependent on the type of pollutant, as well as a range of conditions including rainfall, inflow volumes, temperature and wind.

Results for water quality upstream, within and downstream of Lake Ginninderra shows that the lake does not appear to be consistently mitigating pollutants to the downstream receiving waters. This is evidenced by higher annual average phosphorus concentrations downstream of the lake in most years from 2014 to 2021 (Figure 6.41).

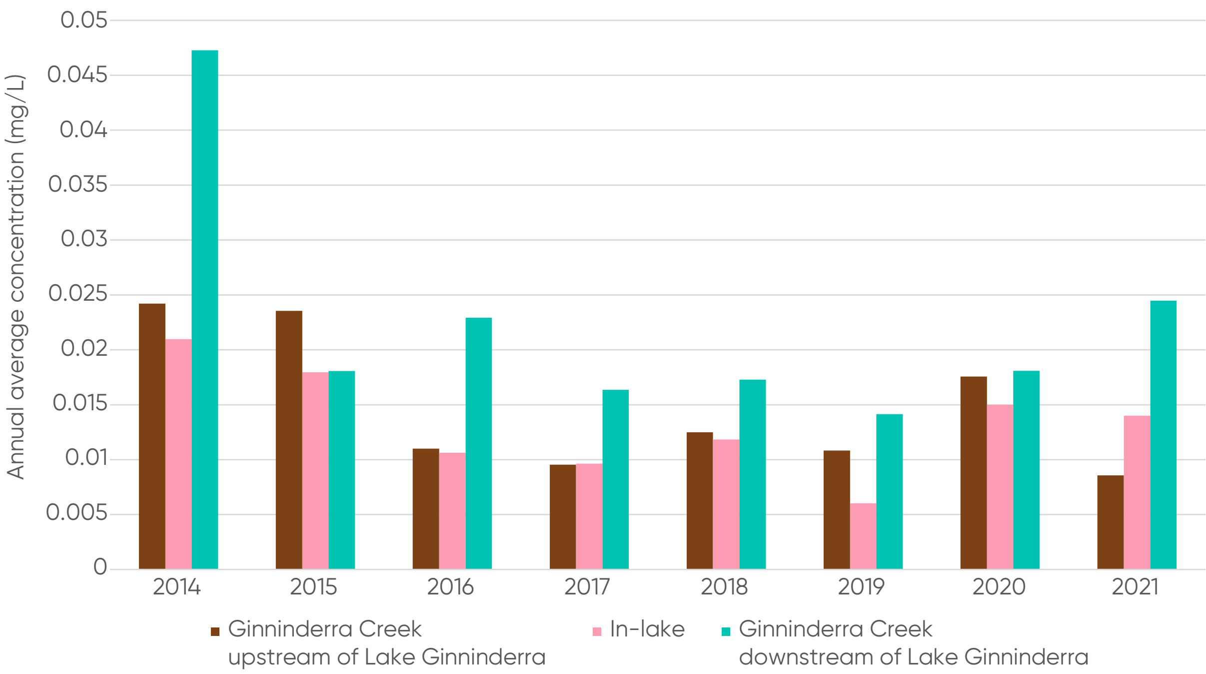



**Figure 6.41.** Annual average total phosphorus concentrations for Ginninderra Creek upstream and downstream of Lake Ginninderra, and in the lake surface waters, 2014 to April 2021.

**Data sourced from:** Data are combined from Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

**Note:** Data are averages for each calendar year.

Results for annual average nitrogen (as nitrate) concentrations were variable with some years having higher concentrations downstream of the lake from 2014 to 2021, but for other years, concentrations were lower downstream of the lake (Figure 6.42). Notably, for most years the in-lake annual average nitrogen concentrations were lower than both upstream and downstream sites, the reasons for this are not clear.

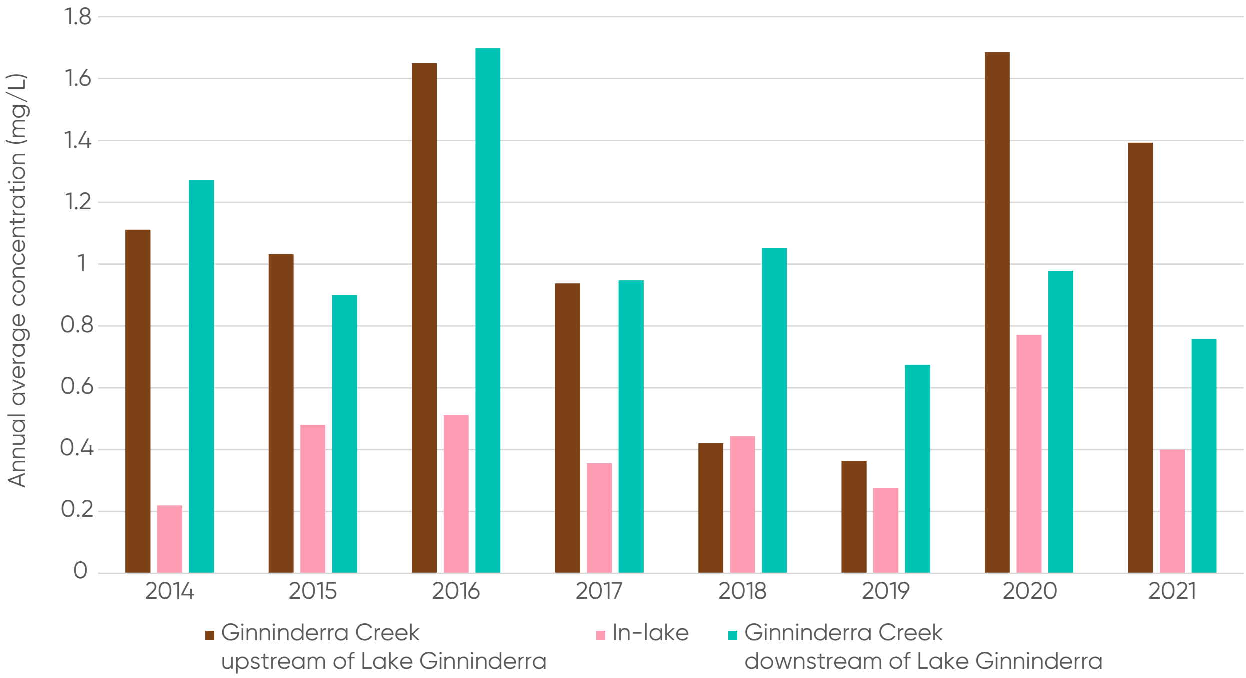



**Figure 6.42.** Annual average nitrate concentrations for Ginninderra Creek upstream and downstream of Lake Ginninderra, and in the lake surface waters, 2014 to April 2021.

**Data sourced from:** Data are combined from Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

**Note:** Data are averages for each calendar year.

Annual average turbidity from 2011 to 2021 showed that levels downstream of Lake Ginninderra were lower for most years compared to levels upstream (Figure 6.43). In-lake turbidity was also found to be lower in most years compared to both upstream and downstream levels. This suggests that the lake is mitigating turbidity issues.

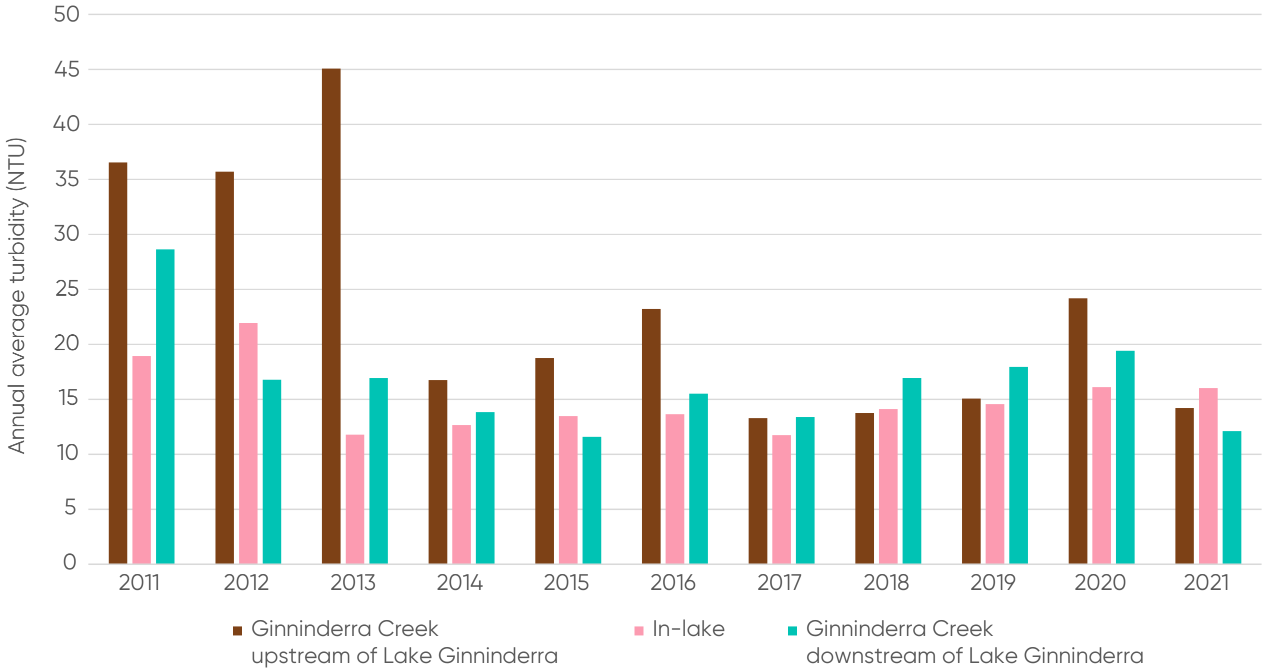



**Figure 6.43.** Annual average turbidity for Ginninderra Creek upstream and downstream of Lake Ginninderra, and in the lake surface waters, 2011 to April 2021.

**Data sourced from:** Data are combined from Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

**Note:** Data are averages for each calendar year.

The comparison of water quality upstream and downstream of Lake Ginninderra is difficult because of the data limitations associated with routine monitoring and sampling coverage. Data that would inform the water quality performance of Lake Ginninderra are confined to the main stem of Ginninderra Creek with no information available about the water quality from the stormwater network on the southern side of the lake. Further, the pollutant inflow and outflow data from Ginninderra Creek are biased to low flow periods which does not enable a fair evaluation of the lake's performance given that the concentrations of pollutants in high flows is considerably increased compared to baseflows. Consequently, the data used for this Investigation are not well suited to evaluating the water quality mitigation performance of Lake Ginninderra.

Because the results presented here are influenced by the current data limitations, it may well be that Lake Ginninderra is somewhat mitigating the impact of the pollutant inflows. At the very least, results for water quality upstream and downstream of Lake Ginninderra suggests that the lake is not having an adverse effect on water quality. This is demonstrated by results showing that the concentrations of pollutants in Lake Ginninderra were not significantly different to those recorded in Ginninderra Creek both upstream and downstream of the lake.

For an accurate assessment of the water quality mitigation performance of Lake Ginninderra, event-based sampling is required to determine accurate pollutant levels upstream and downstream of the lake, as well as significantly improved data on lake inflows and pollutant loads.

## Biodiversity and ecosystem health for Lake Ginninderra

There are little data or research available that would allow a comprehensive assessment of the broader ecological values of Lake Ginninderra.

Waterwatch provides the only systematic and regular evaluation of Lake Ginninderra's ecological condition based on water quality, macroinvertebrates and riparian condition measured at three sites around the lake.[140] Results from the evaluations are published in the annual Catchment Health Indicator Program reports (CHIP). The past three CHIP reports (2018 to 2020) have provided an overall assessment for Lake Ginninderra as being in fair condition with macroinvertebrate communities also classed as fair.

Waterwatch has undertaken a Rapid Assessment of Riparian Condition at Lake Ginninderra in 2015, 2017, 2019 and 2021. In all these years, the overall condition of the vegetation was considered poor. However, for the urban parkland environments that surround the lake, the riparian assessment methodology used by Waterwatch will likely give low scores and is perhaps not a suitable approach. In such highly managed environments, a set of clear expectations needs to be developed to better understand the condition of vegetation on the lakeshore.

There is no current information or long-term data on macrophyte extent and condition in Lake Ginninderra. Most of the lake margins have fringing reedbeds which is in contrast to Lake Tuggeranong and Lake Burley Griffin. Their presence is indicative of a better ecological condition.

Wildlife observations have found birds such as the Crested Shrike-tit and White Winged Triller utilise the shrubs and trees surrounding Lake Ginninderra, while Superb Parrots and Regent Honeyeater use Ironbark as a food source. Reed beds provide habitat for waterbirds such as Black Swans and Moorhens, and animals such as turtles, frogs, and macroinvertebrates. The lake is also home to the Rakali (or Australian Water Rat), appearing relatively abundant in all areas of Lake Ginninderra. Patches of native vegetation exist, including the woodland on the peninsula on the northern end of the lake with yellow box gum.

## Fish

Regular stocking has seen nearly 670,000 native fish stocked to selected Canberra waters from 2011–12 to 2020–21. For Lake Ginninderra, this includes the stocking of around 95,300 Murray Cod, and 72,100 Golden Perch.[141] This accounts for around 30 per cent of the Murray Cod and 20 per cent of the Golden Perch stocked to Canberra's urban waters. In addition to stocked fish, self-sustaining populations of Western Carp Gudgeon are also known to be present in Lake Ginninderra.

140. O'Reilly, W., et al., 2021. *Catchment Health Indicator Program: Report Card 2020*. Upper Murrumbidgee Waterwatch, Canberra.
141. Environment and Planning Directorate, 2015. *Fish Stocking Plan for the Australian Capital Territory 2015-2020*. ACT Government, Canberra.

Fish populations in Lake Ginninderra are surveyed every two–three years by the ACT Government. Results show that the water quality and ecosystem health of the lake are sufficient for the survival of stocked native fish, with no evidence of high mortality rates. There have been no native fish kills in Lake Ginninderra, although the deaths of more than 100 invasive Redfin Perch were reported in 2013, and more than 20 invasive European Carp in 2020.

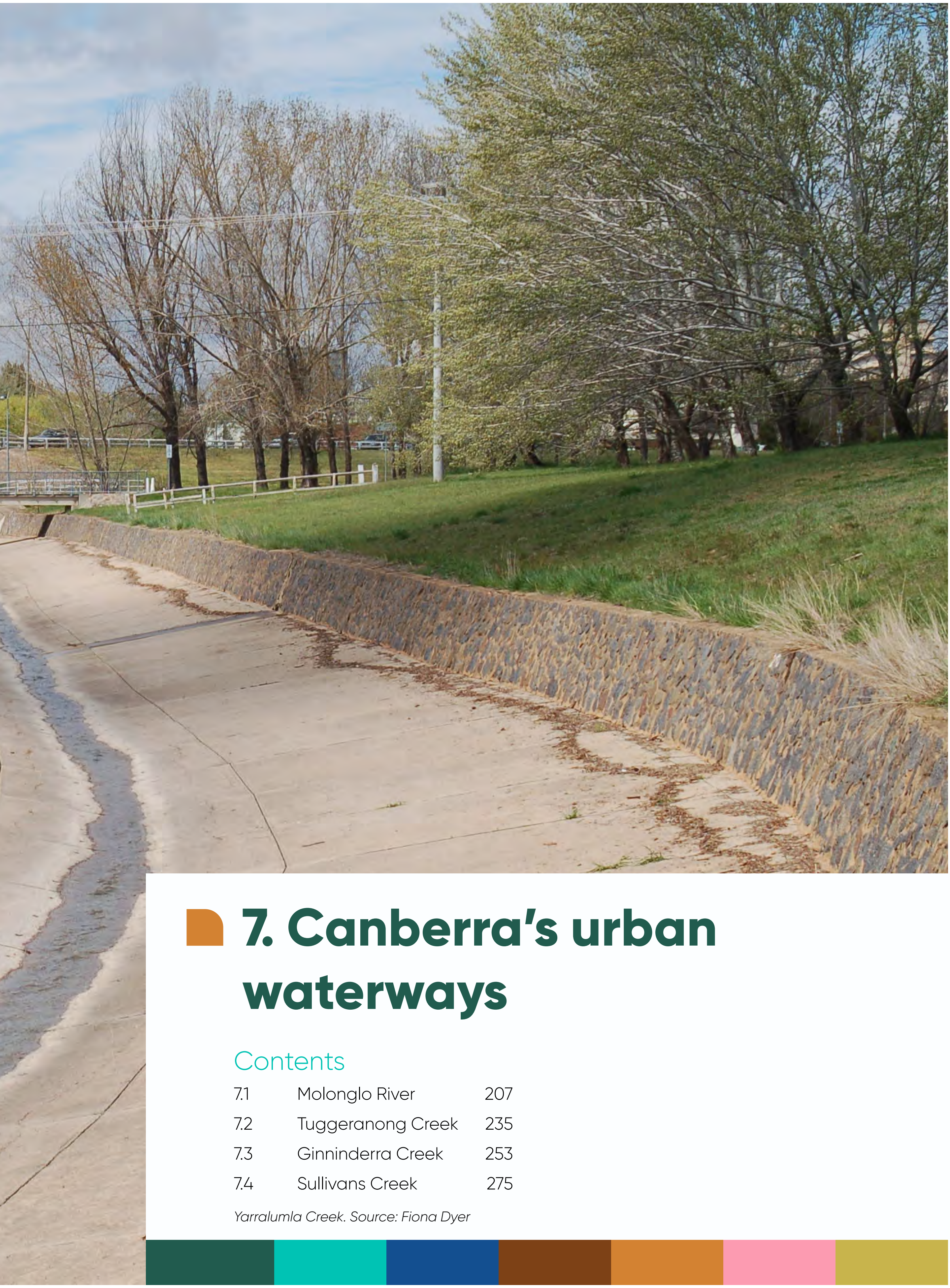
Lake Ginninderra supports populations of European Carp and Redfin Perch, both invasive species that have negative effects on water quality and other fish species.

### 6.3.5 Knowledge gaps for Lake Ginninderra

Lake Ginninderra and its inflowing waters have received considerably less attention with regard to water quality and flow monitoring compared to other Canberra lakes. This means that there is limited data that could inform an evaluation of the lake's performance in reducing downstream pollution, and perhaps more importantly, to enable predictions of future issues to inform management decisions. Given the urban expansion in the catchment, improved knowledge is also vital to ensure that the comparatively good water quality in Lake Ginninderra is maintained.

For information on improving water quality and ecosystem health information see section **11.8 Effectiveness of monitoring, evaluation and reporting processes for urban waters**.

*Eastern Long-necked Turtle. Source: Ryan Colley*



# 7. Canberra's urban waterways

Contents



*Yarralumla Creek. Source: Fiona Dyer*

The ACT has seven main creeks and one river that traverse the Canberra urban area. These are the Molonglo River and the Tuggeranong, Ginninderra, Sullivans, Weston, Yarralumla and Kippax Creeks (Figure 7.1). This Investigation assesses the state of the Molonglo River (upstream and downstream of Lake Burley Griffin), Sullivans Creek, Tuggeranong Creek and Ginninderra Creek. Other waterways have not been evaluated because extensive data sets are not available.

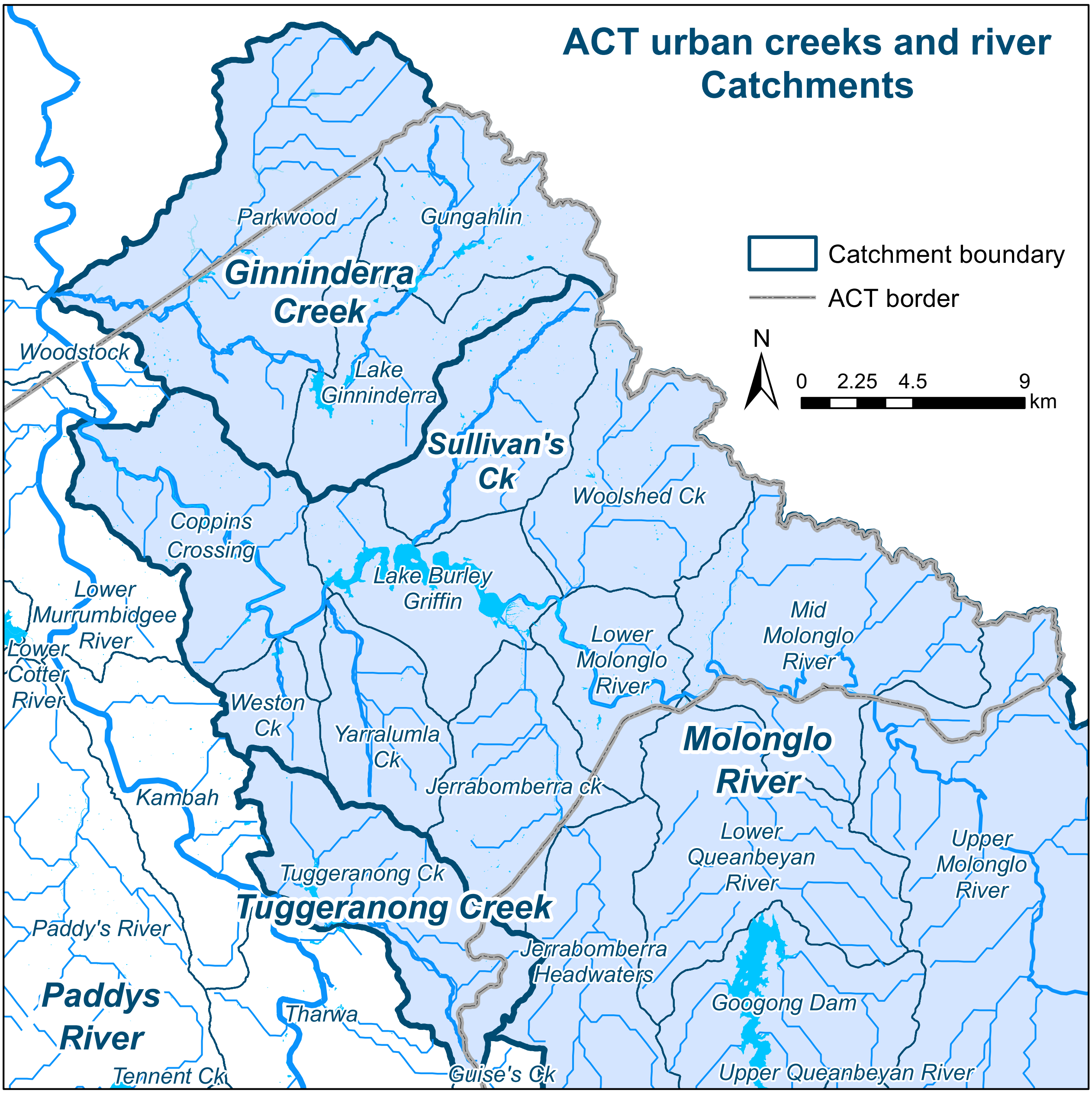



**Figure 7.1.** ACT urban waterways and catchments.

**Source:** University of Canberra, Centre for Applied Water Science. Data from ACT Government.

## Known urban waterway issues

Canberra's urban waterways are characterised by a combination of natural and modified aquatic environments. Modified environments, such as open concrete drains, significantly reduce habitat and landscape values through engineered changes to channels and the removal of riparian vegetation. These prevent many of the natural features and processes that are vital for aquatic health, biodiversity and the maintenance of water quality.

Modified aquatic and catchment conditions are known to subject waterways to a range of water quality issues such as high nutrient concentrations, sedimentation, turbidity, salinity, and contamination by heavy metals and other pollutants. In cases of very poor aquatic health and/or a lack of riparian vegetation, the recreational opportunities and visual amenity of waterways are significantly reduced impacting on community health and wellbeing.

There has been little research on the ACT's urban waterways, with water quality research tending to be confined to understanding urban nutrients in specific creeks and rivers, and heavy metal contamination in the Molonglo River downstream of Captains Flat mine.

Like many urban waters, the concentrations of nutrients in ACT's urban waterways often exceed guideline levels and result in problems in receiving waters including Canberra's urban lakes and the Murrumbidgee River. High concentrations of nutrients in Canberra's urban creeks were identified during rapid development of the Tuggeranong and Ginninderra districts.[142,143] However, research over the past 20 years indicates that the high concentrations of nutrients have persisted and are not just associated with the construction phase of the urban areas.[144,145,146,147]

While high concentrations of nutrients in urban creeks are not unusual, the proportion of the nutrients which are being transported in dissolved form in Canberra's urban creeks and rivers is notable. In the late 1990s, total phosphorus concentrations in Sullivans Creek were observed to be consistently higher than in other ACT streams, with between 40 per cent and 80 per cent of the phosphorus in dissolved form.[148] It also was noted at that time as being unusually high compared with other Australian inland streams. More recent research has highlighted that up to 50 per cent of the phosphorus transported in the creeks draining into Lake Tuggeranong was in dissolved form, even in high flow events.[149] Dissolved phosphorus is a nutrient form that is more readily available for algal growth and can result in cyanobacterial blooms. The high proportion of dissolved nutrients poses considerable challenges for the management of urban water quality as much of the water sensitive urban design measures are not designed to handle a significant proportion of dissolved nutrients.

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142. Beer, T., et al., 1982. *Environmental water quality: a systems study in Tuggeranong Creek and Kambah Pool.*, CRES Monograph 5, Centre for Resource and Environmental Studies, Australian National University, Canberra.
143. Cullen, P., Rosich, R,. and Bek, P., 1978. *A phosphorus budget for Lake Burley Griffin and management implications for urban lakes*. Technical Paper-Australian Water Resources Council (Australia).
144. Dyer, F., 2000. *Nutrients in Sullivans Creek CSIRO Land and Water Technical Report, vol 2/00*. CSIRO Land and Water, Canberra.
145. Ubrihien, R., et al., 2019. *Urban Ponds Research Project Final Report*. A report to the ACT Government by the Institute for Applied Ecology. University of Canberra.
146. Ubrihien, R., et al., 2019. *Lake Tuggeranong Research Project: Research findings and recommendations*. A report to the ACT Government from the Institute for Applied Ecology, University of Canberra.
147. Ubrihien, R., et al., 2020. *Lake Tuggeranong Research Project Report: Stage 3*. A report to the ACT Government from the Centre for Applied Water Science, University of Canberra, Canberra.
148. Dyer, F., 2000. *Nutrients in Sullivans Creek CSIRO Land and Water Technical Report, vol 2/00*. CSIRO Land and Water, Canberra.
149. Ubrihien, R., et al., 2019. *Lake Tuggeranong Research Project: Research findings and recommendations*. A report to the ACT Government from the Institute for Applied Ecology, University of Canberra.

## Riparian character of Canberra's urban waterways

The riparian vegetation of urban waterways consists of both native and invasive plant species, comprising grasses, trees, and shrubs. This vegetation acts as a habitat for birds, amphibians, reptiles and small mammals that live in riparian zones. Streamside vegetation provides refuge for aquatic animals and water bugs. Riparian and in-stream vegetation is threatened by the volume and velocity of stormwater flows caused by rainfall runoff from urban areas.

Waterways form an important part of the hydrological cycle, moving water across the landscape and transporting large amounts of nutrients and wastes. Streams with excellent riparian vegetation act as a filtration system, removing pollutants from rainfall runoff and recharging the groundwater system.

In many suburbs, waterways such as Sullivans Creek and Yarralumla Creek have been artificially lowered and concrete lined to improve the transport of floodwaters away from property. In these areas, the riparian zone consists of mown grass and lacks the ecological values that would support healthy aquatic ecosystems and biodiversity.

Waterwatch assesses the riparian condition of some of Canberra's urban waterways. The long-term data indicate that the vegetation condition across ACT's waterways is poor for around 60 per cent of the surveys undertaken (Figure 7.2). No urban waterway sites have recorded riparian zones in excellent or good condition. Tuggeranong Creek upstream of Lake Tuggeranong has riparian areas in particularly poor health recording a degraded condition for 70 per cent of the time.

*Sullivan's Creek - Fiona Dyer*

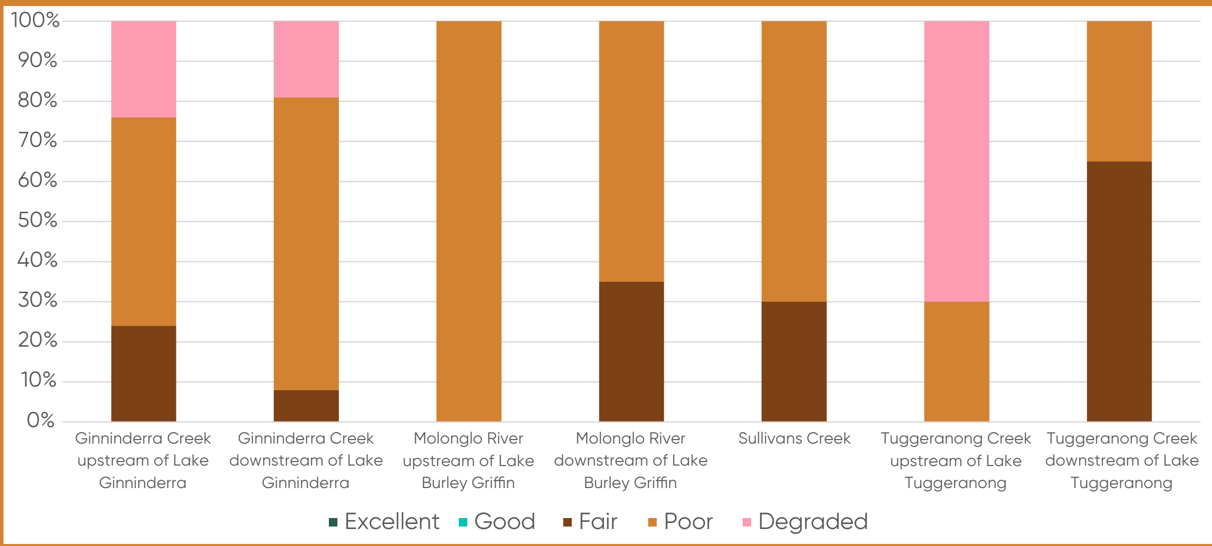



**Figure 7.2.** Waterwatch riparian condition scores, 2015 to 2021 for selected urban waterways in the ACT.

**Data sourced from:** Waterwatch

**Notes:** Assessments based on the Waterwatch Rapid Appraisal of Riparian Condition scores. Data are the total number of scores in each category.

These results show that there is a need to improve the riparian condition of urban waterways. This would not just benefit the aquatic health and biodiversity but also vastly improve the aesthetic and recreational value of the waterways for the Canberra community.

## 7.2 Knowledge gaps for urban waterways

This Investigation has found the following key knowledge gaps for Canberra's urban waterways:

- The lack of planning and management guidance for urban waterways makes it challenging to assess the status of waterway health or whether the desired condition or quality is being met. This is a significant knowledge gap that severely compromises assessments of waterway condition and management effectiveness.
- Long term consistent data sets are not available for many sites within the ACT monitoring network, including for water quality and flow data. Consequently, it is very difficult to compile long-term data assessments for even just a few urban waterway sites.
- The routine monitoring (based on set time intervals) undertaken for the ACT's urban waterways often misses significant pollution events and is not sufficient to accurately assess water quality.

For information on improving water quality and ecosystem health information see section **11.8 Effectiveness of monitoring, evaluation and reporting processes for urban waters**.

# 7.1 Molonglo River



*Molonglo River. Source: Ryan Colley*

### 7.1.1 Molonglo River main findings and key actions

#### Condition assessment against management and community values

There is currently no dedicated strategy or specified outcomes for the management of urban waterways in the ACT. Consequently, the values used in this Investigation to assess the state of urban rivers and creeks are based on selected outcomes in the *ACT Water Strategy 2014–44*.[150] These outcomes include the protection and restoration of aquatic ecosystems and for the community to enjoy and have access to healthy waterways. For this assessment, recreational values of the Molonglo River downstream of Lake Burley Griffin only relate to activities on lands immediately surrounding the waterbody, they do not include primary contact activities such as swimming. There are two designated recreational sites for canoeing and water skiing upstream of the lake. The assessments are informed by the data findings discussed in section **7.1.3 Data trends for the Molonglo River**.

150. Environment and Planning Directorate, 2014. *ACT Water Strategy 2014-44: Striking the balance*. ACT Government, Canberra.

| Value | Status | Condition | Trend | Data quality |
|---|---|---|---|---|
| **MR1:** Is the water quality of the Molonglo River sufficient to support the recreational and aesthetic functions? | **Lower Molonglo River**<br>There are no primary contact recreation sites in the lower Molonglo River but aesthetic values are important for other recreation activities. Turbidity levels are regularly outside of the acceptable range, degrading the aesthetic values of the river. Increased turbidity levels are from sediment runoff caused by urban development in the Molonglo Valley and impacts will likely worsen in the future. The historic loss of riparian vegetation also impacts on the aesthetic value of the river, although current revegetation activities seek to address this. | Fair | ↓ | ●●● High |
| | **Upper Molonglo River**<br>The river's primary contact sites upstream of Lake Burley Griffin have very few closures, typically less than 4 per cent of the recreation season. However, turbidity levels are regularly outside of the acceptable range which impacts on aesthetic values. | Fair | - | ●●● High |
| **MR2:** Does the aquatic health of the Molonglo River support ecological values? | **Lower Molonglo River**<br>High turbidity levels, the loss of riparian habitat and increased sedimentation have significantly impacted on aquatic ecosystem health in some river areas. Although Waterwatch assessments have found macroinvertebrate communities to be in mostly good condition, riparian health is classed as fair to poor. The presence of native fish is also limited by water quality and other pressures on the river. The urban development in the Molonglo Valley is further degrading ecological values and impacts will likely worsen. | Fair | ↓ | ●●○ Moderate |
| | **Upper Molonglo River**<br>The river's upper reaches are impacted by high turbidity levels and riparian areas are classed as in poor condition in Waterwatch assessments because of the lack of native vegetation. Macroinvertebrate communities are generally in good condition but fish populations are known to be dominated by invasive species. Overall, the upper Molonglo River demonstrates a degraded ecosystem health, with far less ecological value in comparison to the lower river reaches. | Poor | ? | ●●○ Moderate |

## Indicator assessment legend

### Condition

- Good = Environmental condition is healthy OR pressure likely to have negligible impact on environmental condition/human health/waterbody values.
- Fair = Environmental condition is neither positive or negative OR pressure likely to have limited impact on environmental condition/human health/waterbody values.
- Poor = Environmental condition is under significant stress, OR pressure likely to have significant impact on environmental condition/human health/waterbody values.
- Unknown = Data is insufficient to make an assessment of status and trends.

### Trend

- ↑ Improving
- ↓ Deteriorating
- \- Stable
- ? Unclear

### Data quality

- ●●● High = Adequate high-quality evidence and high level of consensus
- ●●○ Moderate = Limited evidence or limited consensus
- ●○○ Low = Evidence and consensus too low to make an assessment

## Molonglo River main findings

**Catchment**

- The Molonglo River drains a catchment area of just under 2,000 $km^2$, approximately one-third of which is the catchment of the Queanbeyan River.
- The entire Molonglo catchment comprises a mix of urban (9%), rural (64%) and conservation/recreation land uses (27%).
- Urban areas represent a significant proportion of the Molonglo River's catchment within the ACT.

**Flows 2011 to 2021**

- The annual inflows for the Molonglo River are reduced in most years by Googong Dam which diverts water from the Queanbeyan River.
- Discharges from the Queanbeyan Sewage Treatment Plant can be a substantial source of flow for the Molonglo River during drought periods. In 2019, it contributed nearly 40 per cent of additional flows. Whilst this is an important source of water, it introduces higher nutrient concentrations to the river in dry periods, increasing the risk of cyanobacterial blooms in Lake Burley Griffin.

**Water quality**

*Nutrients 2014 to July 2021*

- Concentrations of phosphorus recorded in the upper and lower reaches of the Molonglo River were commonly within the acceptable range.
- Nitrogen (as nitrate) concentrations were regularly outside of the acceptable range. Annual compliance with guideline levels in the upper Molonglo River ranged from 0 per cent to 54 per cent. For the lower Molongo River, compliance ranged from 0 per cent to 74 per cent.
- Nitrogen concentrations were found to be higher in the upper Molonglo River in comparison to the lower reaches. This shows that Lake Burley Griffin is trapping some of the nitrogen and preventing its movement downstream.
- The high concentrations of nitrogen in the river were likely to have adverse effects on the instream aquatic ecosystems.

*Turbidity 2011 to July 2021*

- High turbidity levels and associated sediment inputs are of particular concern for aquatic health in the lower Molonglo River.
- Turbidity levels were regularly outside of the acceptable range for both the upper and lower Molonglo River. In the upper Molonglo River, annual compliance with guideline levels ranged from 0 per cent to 65 per cent. For the lower Molongo River, compliance was highly variable, ranging from 0 per cent to 100 per cent.

- Since 2019, the turbidity in the lower Molonglo River has increased notably. More than 70 per cent of the turbidity levels recorded in the lower Molonglo River in 2020 and 2021 were above the acceptable range with some particularly high readings. The increase in turbidity is highly likely to be from sediment runoff caused by urban development in the Molonglo Valley.
- Turbidity issues suggest that sediment contributions from urban development are negating the water quality benefits provided by Lake Burley Griffin. This highlights the need to better manage the runoff from the urban development occurring in the Molonglo Valley.

*Dissolved oxygen, pH and conductivity 2011 to July 2021*

- Concentrations of dissolved oxygen were generally within the acceptable range with more than 80 per cent compliance in most years for the upper and lower reaches of the Molonglo River. There were periods of low compliance, including as little as 50 per cent in 2012 and 2013 in the lower Molonglo. The reasons for the low dissolved oxygen in these years is not known.
- Water pH in the upper and lower Molonglo River was within the acceptable range for most years.
- Electrical conductivity recorded in the upper and lower Molonglo River was within the acceptable range for most years. There was an increase in conductivity between 2018 and 2019, particularly in the upper Molonglo River, likely because of the drier conditions.

*Recreational water quality 2015–16 to 2020–21*

- The Molonglo River had very few closures because of cyanobacteria and enterococci concentrations, typically less than 4 per cent of the recreation season. Cyanobacteria was rarely the cause of closures, only occurring for two weeks in 2018–19.

**Ecosystem health 2011 to 2021**

- The ecosystem health of lower Molonglo River is influenced by large areas of urban development adjacent to the Molonglo River Reserve.

*Riparian health*

- Much of the riparian habitat has been historically cleared. This, along with increased sedimentation, has led to a loss of instream habitat.
- Riparian vegetation in the lower Molonglo River has become patchier and less connected, with some very narrow riparian sections.
- Riparian areas along the Molonglo River are in closer proximity to urban areas compared to other rivers.
- Stream bank stability is of concern in recreational areas along the lower Molonglo River.
- The lower Molonglo River riparian areas are vital connecting corridors for bird species, including threatened species such as the Painted Honeyeater.
- Waterwatch assessments of riparian condition show the upper Molonglo River riparian zone to be in poor condition. Scores for the lower Molonglo reaches were slightly better but still classed as fair to poor condition. The better scores for the lower reaches of the river are because of the greater proportion of native vegetation.

*Macroinvertebrate communities*

- The ACT Government macroinvertebrate monitoring program is limited to one site upstream of Lake Burley Griffin. Consequently, it is not possible for the current program to determine the biological health of the lower Molonglo River.
- The Waterwatch Program provides a more comprehensive coverage of the Molonglo River's biological condition, with macroinvertebrate data collected in both the upper and lower reaches.
- Waterwatch surveys mainly found the macroinvertebrate communities to be in good condition for both the upper and lower Molonglo River.

*Fish*

- Knowledge is limited for fish populations in the Molonglo River with no regular survey work undertaken.
- Fish populations are known to be dominated by invasive species including European Carp, Eastern Gambusia, Oriental Weatherloach and Redfin Perch. These invasive species have negative effects on water quality and other fish species.
- Any native fish populations in the lower Molonglo River are likely impacted by inappropriate flow regimes and thermal pollution resulting from Scrivener Dam, and the treated discharges from the Lower Molonglo Water Quality Control Centre which are thought to prevent some native fish species from moving into the Molonglo River from the Murrumbidgee River.
- Murray Cod are known to occur in the upper and lower Molonglo River. This is likely because of their stocking in Lake Burley Griffin and their subsequent movement upstream, and downstream through dam water releases.
- It is not known whether Murray Cod populations in the lower Molonglo River breed naturally.

*Other plants and animals*

- Platypus are regularly recorded in the Molonglo River below Coppins Crossing during Waterwatch's annual Platypus Month survey program.
- Water rats (Rakali) and turtles are also commonly found in the Molonglo River.
- Frogwatch surveys have found the number of recorded species to be consistently low in the lower Molonglo River.
- Riparian zones in the lower Molonglo River corridor are noted for high bird diversity.
- The riparian zones of the lower Molonglo River provide habitat for the threatened Pink-tailed Worm-lizard, and for several rare or threatened plants in the ACT, including Pale Pomaderris.

## Molonglo River key actions

That the ACT Government:

**Key Action 7.1:** The Molonglo River is currently considered to be a non-urban system in most ACT Government documentation. With the increasing expansion of urban development in the Molonglo River catchment, the river should be classified and managed as an urban waterway downstream of Lake Burley Griffin.

**Key Action 7.2:** To improve knowledge on the biological health of the Molonglo River, the ACT Government macroinvertebrate monitoring program needs to be extended to include the lower Molonglo River sections. This is needed to improve the monitoring of land development impacts.

**Key Action 7.3:** To improve aquatic health in the lower Molonglo River, flushing flows from Scrivener Dam are needed to mitigate water quality impacts during low flow conditions.

Other actions for the Molonglo River are to improve monitoring data. These actions are common to all ACT urban waters and are presented in section **11.8 Effectiveness of monitoring, evaluation and reporting processes for urban waters.**

## 7.1.2 Known pressures on the Molonglo River

The growth of urban development in the Molonglo Valley, and especially the construction phase of new suburbs, has increased the contributions of sediment, nutrients and other pollutants to the lower Molonglo and the Murrumbidgee Rivers. The pressures of urban development on the Molonglo River are discussed in detail in **Chapter 12: Urban development and the ACT's lakes and waterways.**

- As the population increases in the Molonglo Valley, there are also increased pressures on the aquatic ecosystems and riparian zones of the popular recreational sites along the river.
- The Molonglo River upstream of the ACT is affected by the negative impacts of human activities in NSW with regular high concentrations of pollutants, sediment and rubbish present in the river as it crosses the border. Consequently, the quality of water in the Molonglo River is dependent on the management and improvement of aquatic health in both the ACT and NSW.
- The Molonglo River receives treated discharges from the Queanbeyan Sewage Treatment Plant (QSTP), with the current discharges introducing high pollutants loads. However, the contribution that the QSTP makes to the total pollutant loads in the Molonglo River is dependent on the overall flow in the river. During low flow periods, discharges from the QSTP can account for a significant proportion of the river's inflow, and consequently its pollutant loads. The discharges from the QSTP are discussed in the Lake Burley Griffin section (**6.1.1.**).
- The lower Molonglo River also receives treated discharges from the Lower Molonglo Water Quality Control Centre (LMWQCC). These discharges are just upstream of the confluence with the Murrumbidgee River and so do not impact on the vast majority of the Molonglo River. However, it is suggested that the LMWQCC discharges prevent some native fish species from moving into the Molonglo River from the Murrumbidgee River.[151] This has consequences for fish biodiversity in the lower reaches of the river.

151. Pers Comm, Environment, Planning and Sustainable Development Directorate.

*Molonglo River and Jerrabomberra Wetlands. Source: Miranda Gardner*

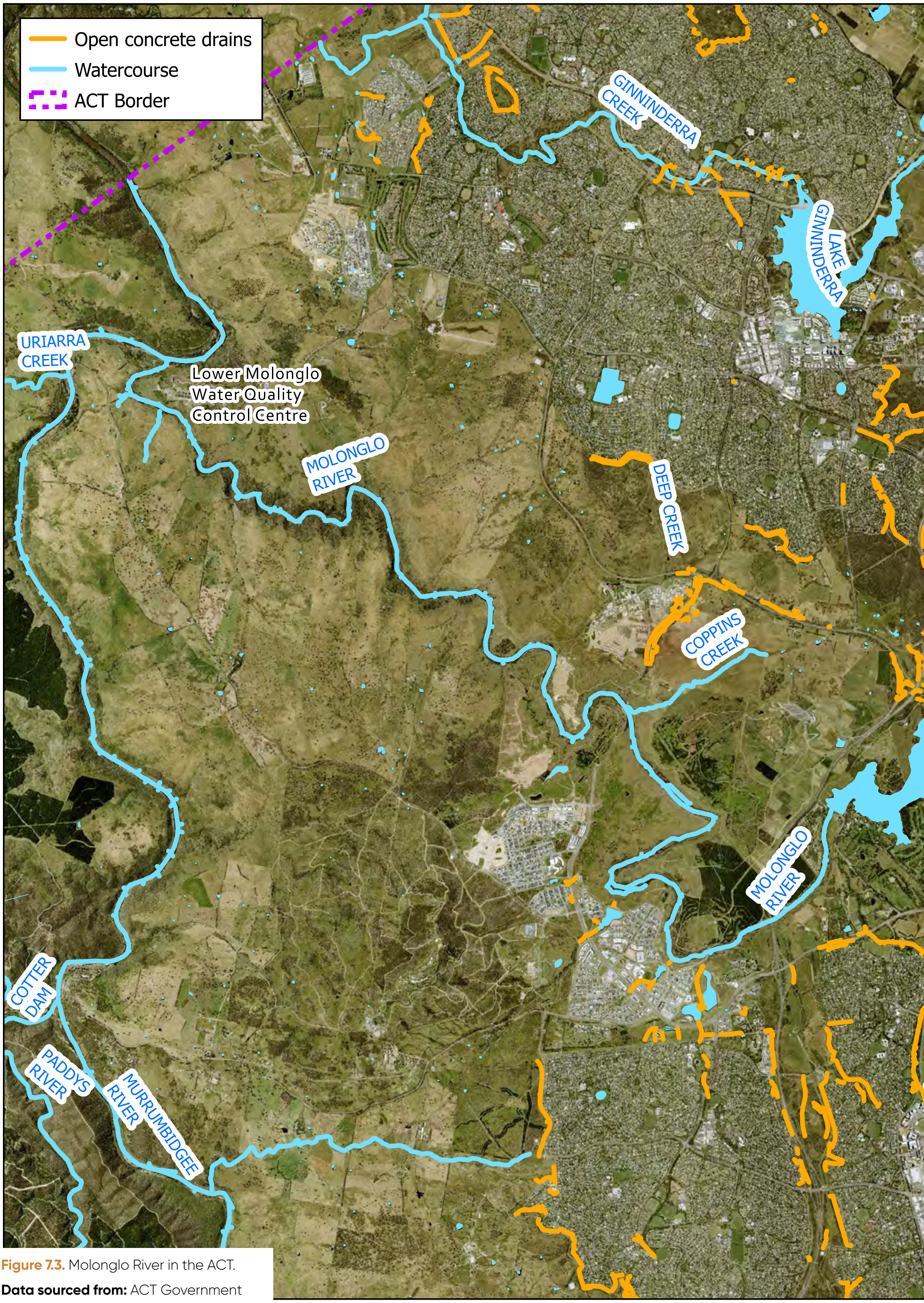
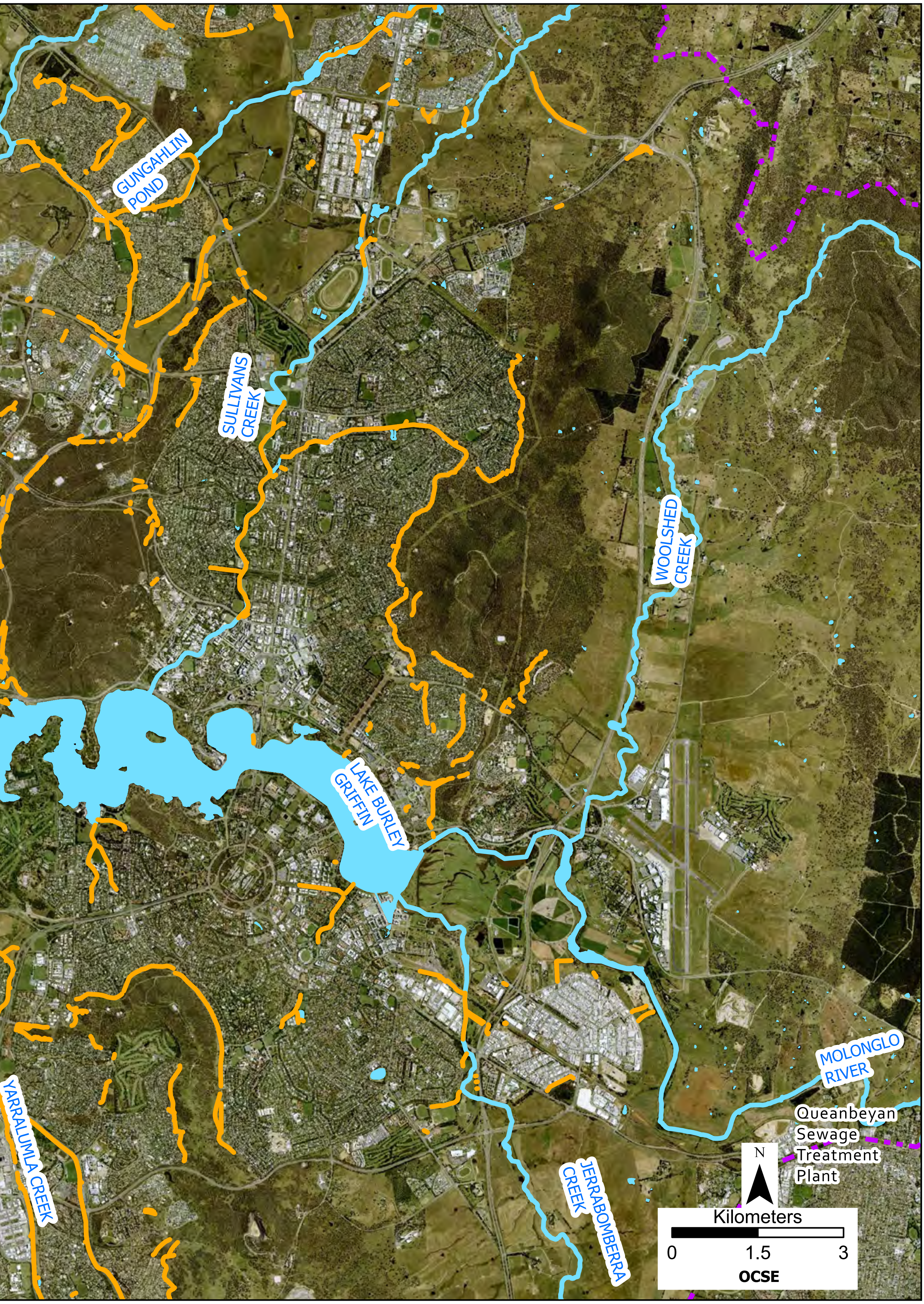



**Figure 7.3.** Molonglo River in the ACT.

**Data sourced from:** ACT Government


GUNGAHLIN POND
SULLIVANS CREEK
WOOLSHED CREEK
LAKE BURLEY GRIFFIN
MOLONGLO RIVER
Queanbeyan Sewage Treatment Plant
YARRALUMLA CREEK
JERRABOMBERRA CREEK
N
Kilometers
0 1.5 3
OCSE

### 7.1.3 Data trends for the Molonglo River

This assessment of the Molonglo River incorporates four sampling locations in the upper reaches (upstream of Lake Burley Griffin), and three in the lower reaches (downstream of the lake). Data is from the Waterwatch program as well as the ACT Government's Lakes and Rivers Water Quality Monitoring Program.

For this Investigation, the Molonglo River is divided into two distinct sections – the upper Molonglo River from the ACT border to Lake Burley Griffin, and the lower Molonglo River downstream of Scrivener Dam to the Murrumbidgee River confluence. It is important that the upper and lower river sections are assessed separately, particularly for water quality. This is because Lake Burley Griffin has a significant influence on water quality in the lower Molonglo River, trapping some of the pollutants that flow through the lake, and modifying aquatic habitat and flow regimes (see section **6.1 Lake Burley Griffin**).

#### Molonglo River catchment and hydrology

**Catchment**

The Molonglo River rises on the western side of the Great Dividing Range in Tallaganda National Park and flows north, then north-west, through Captain's Flat and Queanbeyan before it enters the ACT at Oaks Estate and is joined by the Queanbeyan River. The river then flows west through Canberra where it has been dammed to form Lake Burley Griffin. Downstream of the lake, the river joins the Murrumbidgee River near Uriarra Crossing (Figure 7.3 previous page).

The Molonglo River drains a catchment area of just under 2,000 km$^2$, approximately one third of which is the catchment of the Queanbeyan River. The entire Molonglo catchment comprises a mix of urban (9%), rural (64%) and conservation/recreation land uses (27%) (Figure 7.4). However, the proportion of urban land uses in the Molonglo catchment within the ACT is far greater than for the total catchment. Around 44 per cent of the catchments that surround Lake Burley Griffin are urban land use. This proportion, combined with increasing urban development downstream of Lake Burley Griffin, suggests that urban areas represent a significant proportion of the Molonglo River's catchment within the ACT. The environmental pressures associated with urban development have consequences for current and future water quality and the aquatic health of the Molonglo and Murrumbidgee Rivers.

**Flows**

A number of tributaries contribute flow to the Molonglo River, most are upstream of the ACT border (Figure 7.3). The greatest volume is contributed by the Queanbeyan River, providing between 10 per cent and 80 per cent of the flow in any one year into the Molonglo River at Oaks Estate. The relative contribution from the Queanbeyan River is dependent on the prevailing weather conditions and the operation of Googong Dam.

Annual flows for the Molonglo River upstream (Oaks Estate) and downstream (Coppins Crossing) of Lake Burley Griffin are highly variable in response to rainfall in the catchment (Figure 7.5). The impacts of the drought conditions from 2017 to 2019 are particularly evident, as is the high rainfall experienced in 2021.

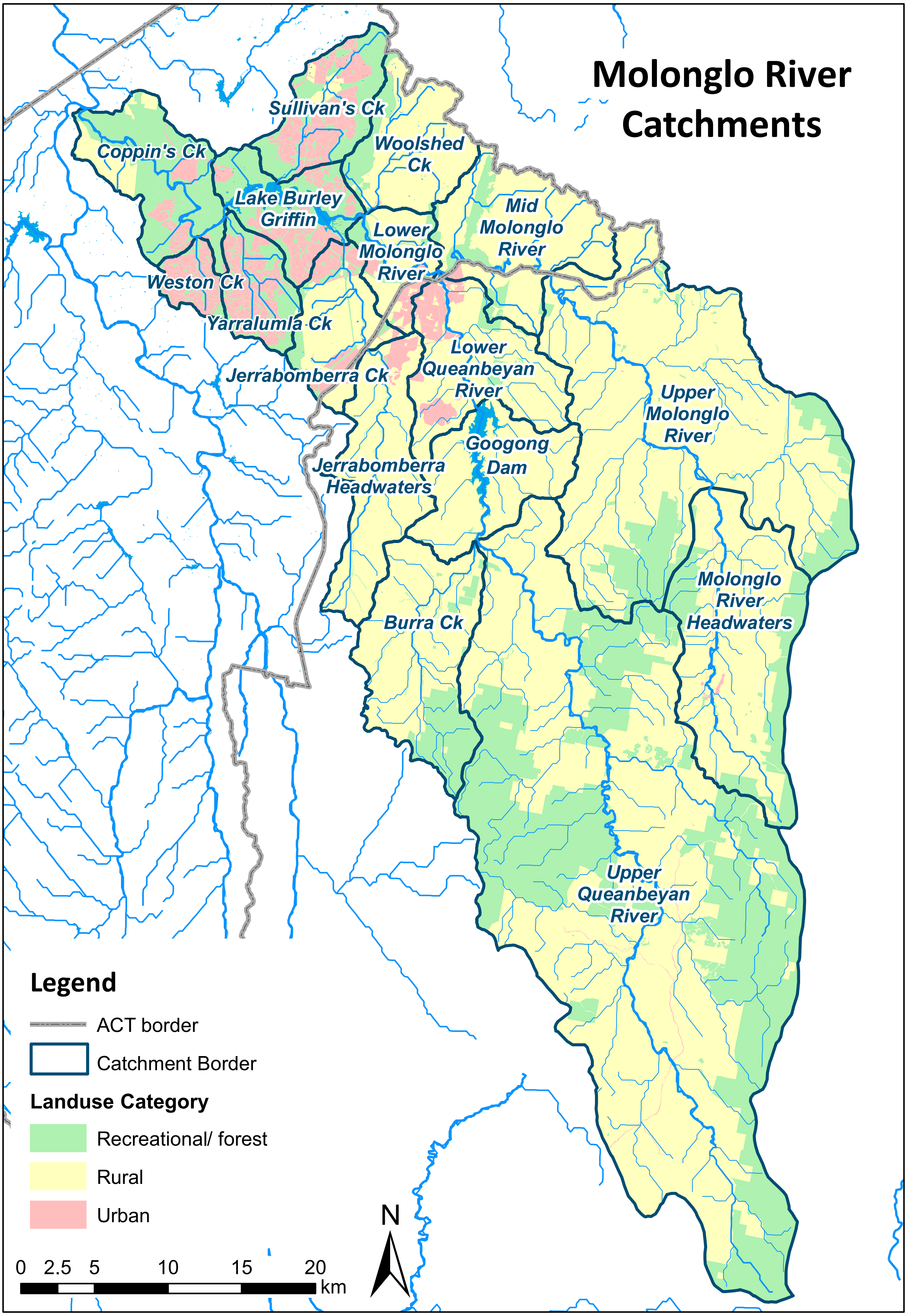



**Figure 7.4.** Molonglo River catchment and land uses.

**Source:** University of Canberra, Centre for Applied Water Science. Data from ACT and NSW Governments.

The relative discharges upstream and downstream of Lake Burley Griffin are generally comparable, with higher discharges downstream the result of additional inflows to Lake Burley Griffin (mainly Sullivans Creek and Jerrabomberra Creek) and downstream of the lake from non-gauged urban watercourses including Yarralumla Creek, Coppins Creek, Holdens Creek, and Deep Creek, as well as urban stormwater inputs from areas such as Denman Prospect.

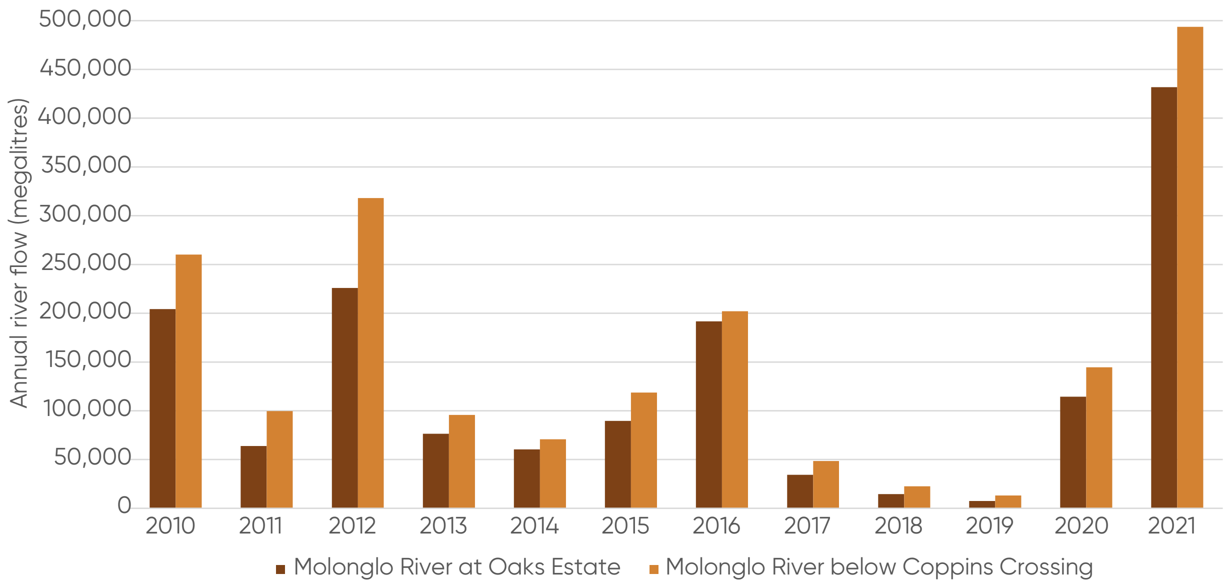



**Figure 7.5.** Annual Molonglo River flows upstream (Oaks Estate) and downstream (Coppins Crossing) of Lake Burley Griffin, 2011 to 2021.

**Data sourced from:** Bureau of Meteorology.

## Impacts of Googong Dam on inflows to the Molonglo River

The annual inflows for the Molonglo River are reduced by Googong Dam which impounds water in the Queanbeyan River for community water supply. Reduced inflows to the lake can cause reductions in both the water level and flow rates, impacting on aquatic health, water quality, and increasing the occurrence of algal blooms. For more information on the flow impacts of Googong Dam see **Inflows to Lake Burley Griffin** section.

Over the 2010 to 2021 period, some 160,000 megalitres of Googong Dam inflows were impounded for community water supply (Figure 7.6). This represents around 16 per cent of total inflows to the dam with this water lost to the Queanbeyan River downstream of the dam, and consequently the Molonglo River and Lake Burley Griffin. It should be noted that not all of the Googong Dam outflows would reach the Molonglo River because of natural losses and water use for rural lands.

The biggest differences between the Googong Dam inflows and outflows occur in wet years following drought periods when water is retained to increase storage levels. In 2010 and 2020, around 28 per cent and 75 per cent of the total inflows (around 69,000 megalitres for both years) were retained in the dam. These years also represent the most water lost to the Molonglo River with the difference between Googong Dam inflows and outflows representing 34 per cent of the river flows upstream of Lake Burley Griffin in 2010, and 60 per cent in 2020. Other years where Googong Dam outflows were lower than inflows represented 15 per cent or less of the Molonglo River flows.

It is interesting to note that during the severe drought years from 2017 to 2019, dam outflows were higher than inflows because of the environmental flow releases, although the volume of inflows were very low. Without this flow requirement, there would be periods with no outflows from the dam during times of severe drought.

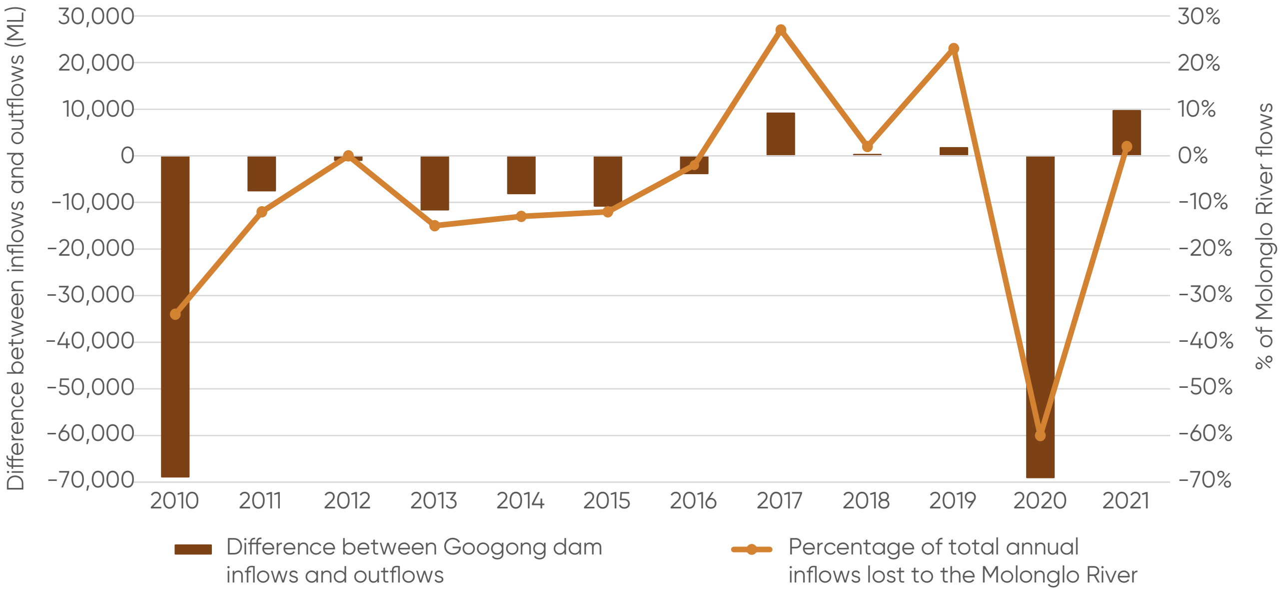



**Figure 7.6.** Difference between Googong Dam inflows and outflows compared to total flows for the Molonglo River upstream of Lake Burley Griffin Lake Burley Griffin, 2010 to 2021.

**Data sourced from:** Icon Water and the Environment, Planning and Sustainable Development Directorate.

**Note:** Molonglo River flows from Oaks Estate upstream of Lake Burley Griffin.

## Discharges from the Queanbeyan Sewage Treatment Plant

The Molonglo River receives water from the Queanbeyan Sewage Treatment Plant (QSTP), which discharges treated wastewater into the Molonglo River upstream of Lake Burley Griffin at Oaks Estate. The QSTP generally discharges a minimum of 3.5 megalitres per day[152] with an annual average daily flow of between seven and 10 megalitres a day from 2010 and 2020. Consequently, during drought periods, the discharge from the QSTP can be a substantial source of flow for the Molonglo River (Figure 7.7). During 2018, the QSTP contributed more than 20 per cent of additional flows to the Molonglo River, and in 2019, nearly 40 per cent. Whilst this additional inflow has become particularly important since the flows in the Queanbeyan River were reduced by the construction of Googong Dam, it does introduce higher nutrient concentrations to the river in dry periods, increasing the risk of cyanobacterial blooms in Lake Burley Griffin.

152. Queanbeyan-Palerang Regional Council, 2020. *Draft Queanbeyan Sewage Treatment Plant Upgrade Environmental Impact Statement*. Queanbeyan-Palerang Regional Council, Queanbeyan.

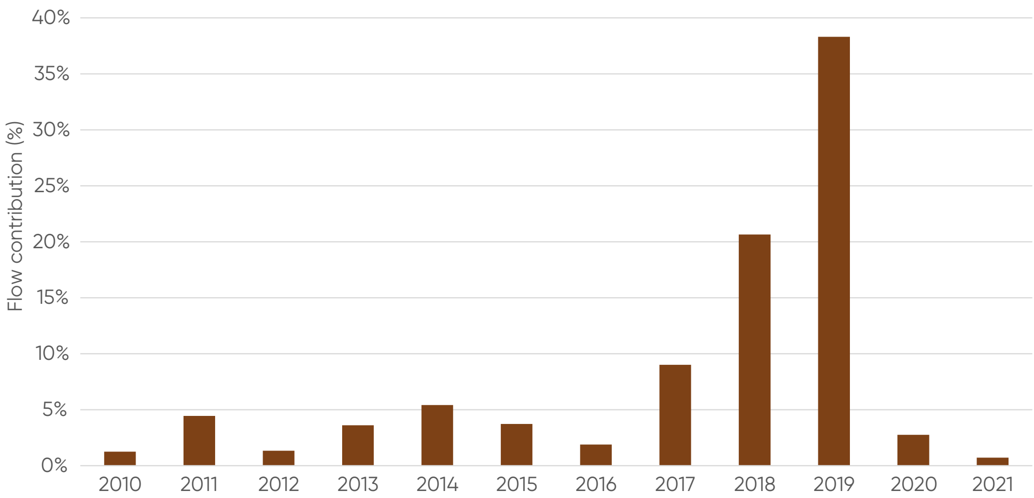



**Figure 7.7.** Additional Molonglo River flows contributed by the Queanbeyan Sewage Treatment Plant, 2010 to 2021.

**Data sourced from:** the Bureau of Meteorology and the Environment, Planning and Sustainable Development Directorate.

**Note:** Percentage contribution figures are based on the estimated annual volume of treated effluent released from the sewage treatment plant as a proportion of the annual flows recorded in the Molonglo River at Oaks Estate, upstream of the treatment plant.

### 7.1.4 Water quality in the Molonglo River

When the Molonglo River flows into the ACT, its water quality and ecosystem health is already degraded. This is caused by pollutants from the rural and urban land uses in NSW, as well as the treated effluent delivered to the river by the Queanbeyan Sewage Treatment Plant. Consequently, the health of the Molonglo River is dependent on the management and improvement of aquatic health in both the ACT and NSW.

#### Phosphorus

Concentrations of phosphorus recorded in the upper and lower reaches of the Molonglo River were commonly within the acceptable range (guideline levels). For the upper Molonglo River, all but two years from 2014 to July 2021 had 100 per cent compliance with guideline levels and for the lower Molonglo River, all but one year achieved 100 per cent compliance. For those years where full compliance was not achieved, more than 90 per cent of samples met guideline levels in both the upper and lower Molonglo River.

#### Nitrogen

Nitrogen (as nitrate) concentrations were regularly outside of the acceptable range. These higher concentrations of nitrogen are likely to have adverse effects on the instream aquatic ecosystems.

From 2014 to July 2021, compliance with guideline levels in the upper Molonglo River ranged from 0 per cent in 2020, to 54 per cent in 2016 (Figure 7.8). For the lower Molongo River, compliance was also poor, ranging from 0 per cent in 2014 to 74 per cent in 2017 (Figure 7.9). There was much variability between the years suggesting that nitrogen levels are strongly related to changing catchment conditions.

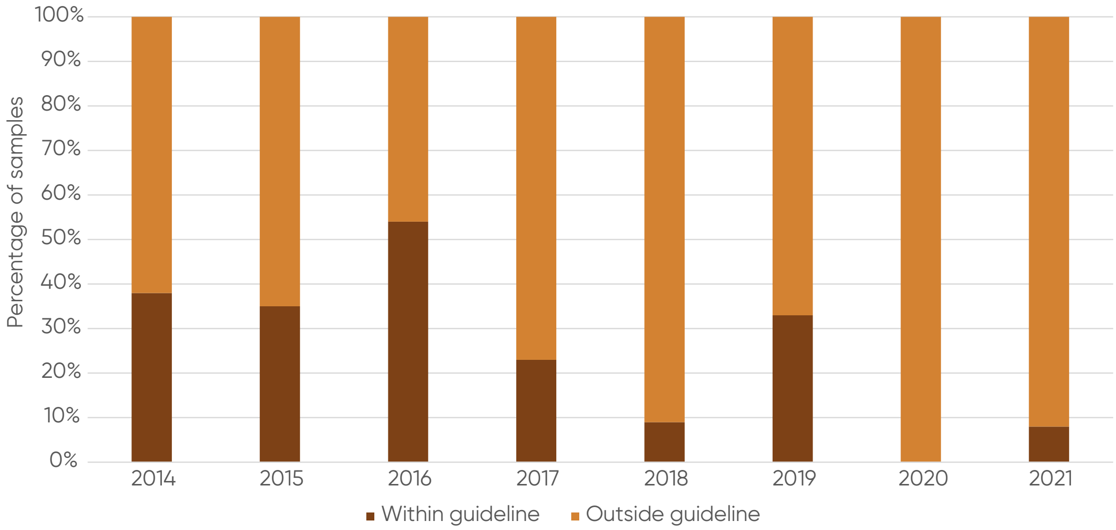



**Figure 7.8.** Annual average of the percentage of nitrate samples within guideline levels in the upper Molonglo River, 2014 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

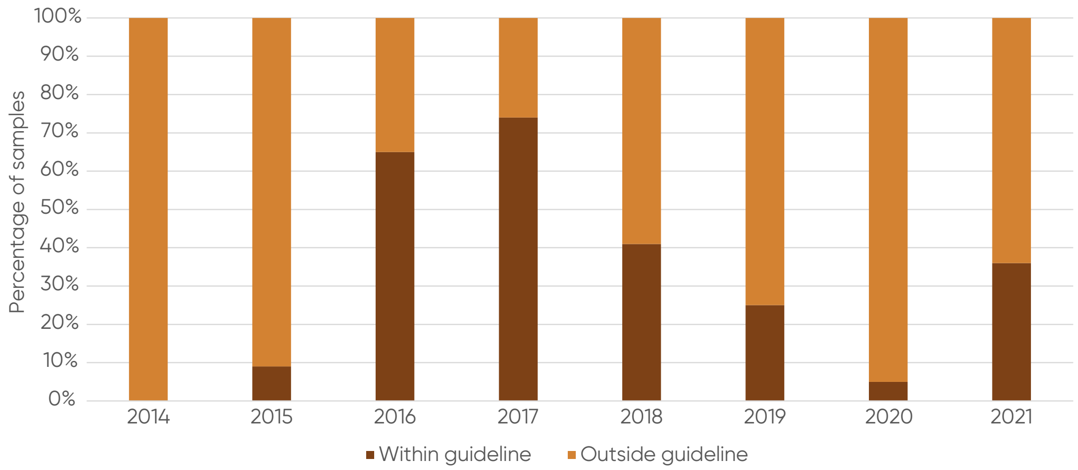



**Figure 7.9.** Annual average of the percentage of nitrate samples within guideline levels in the lower Molonglo River, 2014 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

Nitrogen concentrations were found to be higher in the upper Molonglo River in comparison to the lower reaches. This shows that Lake Burley Griffin is trapping some of the nitrogen and preventing its movement downstream. The Molonglo River nitrogen levels are also increased considerably by the treated effluent released from the Queanbeyan Sewage Treatment Plant which contains high concentrations of nitrogen (see section **6.1 Lake Burley Griffin**).

## Turbidity

High turbidity levels and associated sediment inputs are of particular concern for aquatic health. These have the potential to smother habitat and cause significant impairment of the aquatic ecosystems, reducing the biodiversity and conservation values of the Molonglo River corridor. High turbidity levels also degrade the recreational and aesthetic values of the river.

Turbidity levels were regularly outside of the acceptable range for both the upper and lower Molonglo River. From 2011 to July 2021, compliance with guideline levels in the upper Molonglo River ranged from

0 per cent in 2012 to 65 per cent in 2017 (Figure 7.10). For the lower Molongo River, compliance was highly variable, ranging from 0 per cent in 2011 to 100 per cent in 2014 (Figure 7.11). Variability in turbidity is strongly related to changing catchment conditions, particularly rainfall, with turbidity levels in the lower Molonglo River generally higher during wet periods when there are substantial releases of turbid water from Lake Burley Griffin.

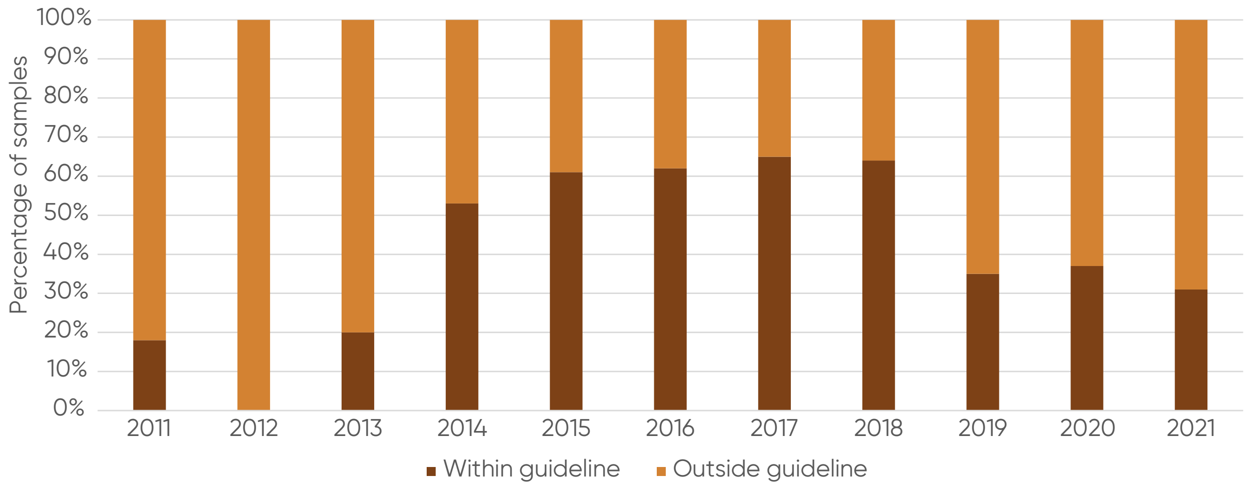



**Figure 7.10.** Annual average of the percentage of turbidity samples within guideline levels in the upper Molonglo River, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

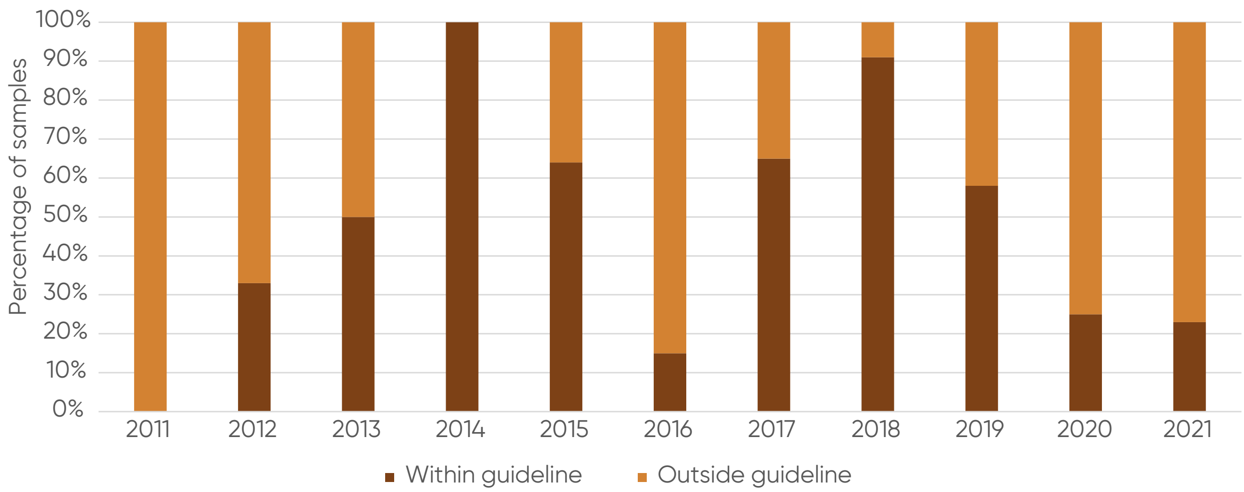



**Figure 7.11.** Annual average of the percentage of turbidity samples within guideline levels in the lower Molonglo River, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

Until recently, turbidity in the lower Molonglo River downstream of Lake Burley Griffin was generally better than that recorded in the upstream reaches, suggesting that the lake was having a positive effect on water quality in the river. Since 2019, the proportion of turbidity readings outside of the acceptable range in the lower Molonglo River has increased notably. In 2020 and 2021, more than 70 per cent of the turbidity levels recorded in the lower Molonglo River were above the acceptable range compared with around 10 per cent to 40 per cent in the preceding three years. This has included some particularly high readings that cannot be attributed to the wetter conditions in those years alone.

The source of the increase in turbidity in the lower Molonglo River is highly likely to be from sediment runoff caused by urban development in the Molonglo Valley (see **Chapter 12: Urban development and the ACT's lakes and waterways**). This may mean that sediment contributions from urban development are negating the water quality benefits provided by Lake Burley Griffin.

The increased turbidity in the lower Molonglo River is of concern and highlights the need to better manage the runoff from the urban development occurring in the Molonglo Valley. This will protect the aquatic ecosystems and maintain the visual and recreational amenity of the river.

### pH

The levels of pH recorded in the upper and lower Molonglo River from 2011 to July 2021 were within the acceptable range for most years. There were only two instances of readings in the upper Molonglo River below the lower limit of pH 6 and for the lower Molonglo River all recorded pH levels were within the acceptable range.

### Dissolved oxygen

Concentrations of dissolved oxygen were generally within the acceptable range with more than 80 per cent compliance in most years from 2011 to July 2021 for the upper and lower reaches of the Molonglo River. The dissolved oxygen levels were also comparable between the river's upper and lower reaches. However, periods of lower compliance have occurred, including as little as 50 per cent in 2012 and 2013 in the lower Molonglo, the reasons for which are not known. Concentrations of dissolved oxygen are influenced by a range of factors including water temperature, the time of day sampling occurs and the level of organic matter in the water. This makes it difficult to interpret results.

### Conductivity

Electrical conductivity (a measure of salt concentration) recorded in the upper and lower Molonglo River from 2011 to July 2021 was within the acceptable range for most years and generally comparable between the upper and lower reaches of the river.

There was an increase in conductivity from 2018 to 2020, particularly in the upper Molonglo River where the percentage of samples within the acceptable range dropped to between 55 per cent and 68 per cent. These results are likely because of the drier conditions. The return of wetter conditions in the second half of 2020 and 2021 led to conductivity values declining again.

## Recreational water quality

The Molonglo River immediately upstream of Lake Burley Griffin is used for water skiing and other boating activity and consequently needs to have water of a quality suited to primary contact. Downstream of the lake the river is not expected to be used for primary contact activities. The ACT Government monitors cyanobacteria and enterococci bacteria levels at two sites immediately upstream of Lake Burley Griffin. Recreational water monitoring results from 2015–16 to 2020–21 show that the Molonglo River had few closures because of cyanobacteria and enterococci concentrations, typically less than 4 per cent of the recreation season. The highest number of closures was four weeks in 2020–21 caused by enterococci concentrations. Cyanobacteria is rarely the cause of closures, only occurring for two weeks in 2018–19.

## Biodiversity and ecosystem health

The ACT Government Conservation Effectiveness Monitoring Program provides the most recent and comprehensive assessment of ecosystem health and biodiversity for the upper and lower Molonglo River.[153]

The main findings include:

- The ecosystem health of lower Molonglo River is influenced by large areas of urban development adjacent to the Molonglo River Reserve for much of the downstream reach.
- Riparian areas along the Molonglo River are in closer proximity to urban areas compared to other rivers with some sections characterised by very narrow riparian zones with minimal connectivity.
- Much of the riparian habitat has been cleared and riparian vegetation in the lower Molonglo River has become patchier and less connected especially outside the ACT reserve network.
- The remaining riparian areas are vital corridors for birds including threatened species such as the Painted Honeyeater, and may provide important refuge habitats for many species in drought periods.
- Instream habitat has been vastly reduced due the lack of riparian vegetation and increased sedimentation.
- Stream bank stability is of concern in recreational areas along the lower Molonglo River.
- Flushing flows from Scrivener Dam are needed in the lower Molonglo River during low flow periods to mitigate increasing water temperatures, improve low dissolved oxygen levels, and to reduce elevated conductivity, nitrogen, and phosphorus levels.

## Macroinvertebrate communities

ACT Government monitoring of the macroinvertebrate communities in the Molonglo River occurs at a single site upstream of Lake Burley Griffin (at the Sutton Road Bridge), with the surveys usually taken each spring and autumn.

153. Malam, C., et al., 2021. *Conservation Effectiveness Monitoring Program: Aquatic and Riparian Ecosystem Condition Assessment and Monitoring Plan. Technical Report*. Environment, Planning and Sustainable Development Directorate, ACT Government, Canberra.

Results show that the macroinvertebrate communities were in better condition in spring than in autumn with more spring surveys showing a similar to reference condition, and fewer spring surveys showing significantly and severely impaired conditions (Figure 7.12). All but one autumn macroinvertebrate survey was found to be significantly or severely impaired, and the autumn surveys in 2020 and 2021 were both found to be severely impaired. The impaired instream biological community is most likely a function of the water quality and degraded in-stream habitat. It may also be the result of drier autumns that have been experienced in the region, rather than any localised conditions or activities.

Because the ACT Government macroinvertebrate monitoring program is limited to this one site, it is not possible for the current program to determine the biological health of the lower Molonglo River. The program needs to be extended to other river sites to obtain a better overview of the biological health of the Molonglo River.

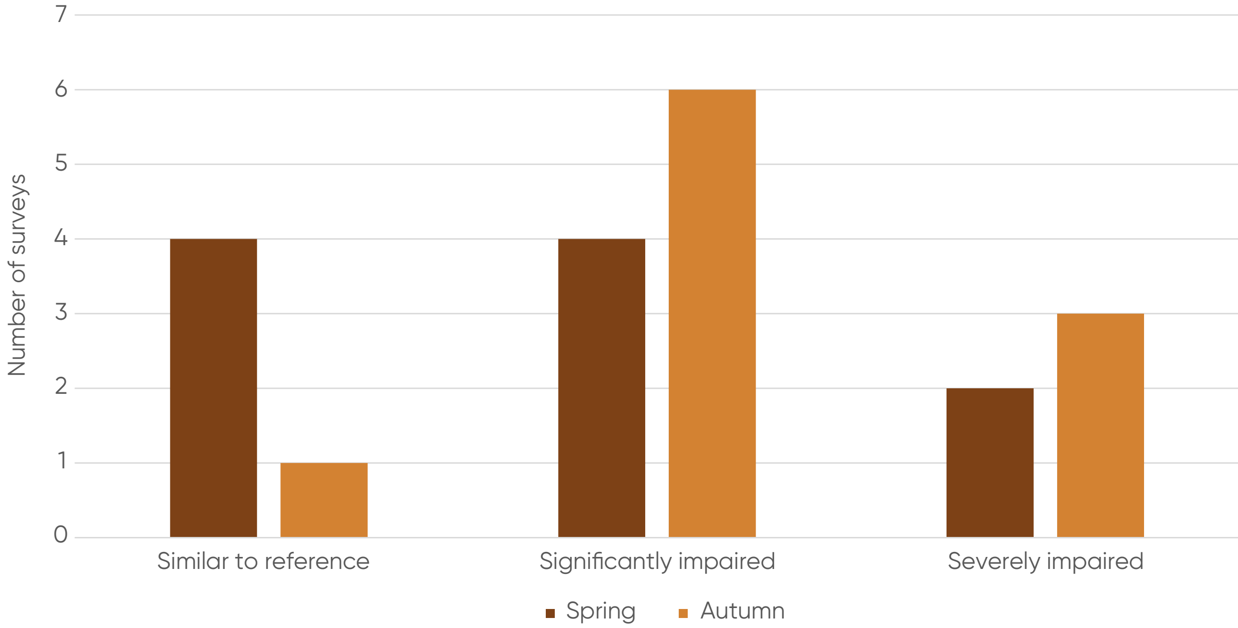



**Figure 7.12.** Macroinvertebrate community health in the Molonglo River at the Sutton Road Bridge, 2011 to 2021.

**Data sourced from:** Environment, Planning and Sustainable Development Directorate.

**Note:** Macroinvertebrate condition is derived from the Australian River Assessment System classifications.

The Waterwatch Program provides a more comprehensive coverage of the Molonglo River's biological condition, with macroinvertebrate data collected in both the upper and lower reaches.[154] Waterwatch surveys macroinvertebrate communities at two sites in the upper reaches (Molonglo River at the Monaro Highway, and at Yass Road, Queanbeyan) and two sites in the lower reaches (Coppins Crossing and 250m upstream of the Murrumbidgee River confluence). The surveys are taken each autumn and spring.

Whilst the Waterwatch surveys mainly found the macroinvertebrate communities to be in good condition for both the upper and lower Molonglo River (Figure 7.13), this was not so with the spring surveys from 2018 to 2020 undertaken just upstream of the confluence with the Murrumbidgee River. This suggests that there may be some seasonal impact on the Molonglo River between Coppins Crossing and the Murrumbidgee River confluence. This may also be attributable to the influence of the Lower Molonglo Water Quality Control Centre but this is uncertain without further investigation.

154. O'Reilly, W., et al., 2021. *Catchment Health Indicator Program: Report Card 2020*. Upper Murrumbidgee Waterwatch, Canberra.

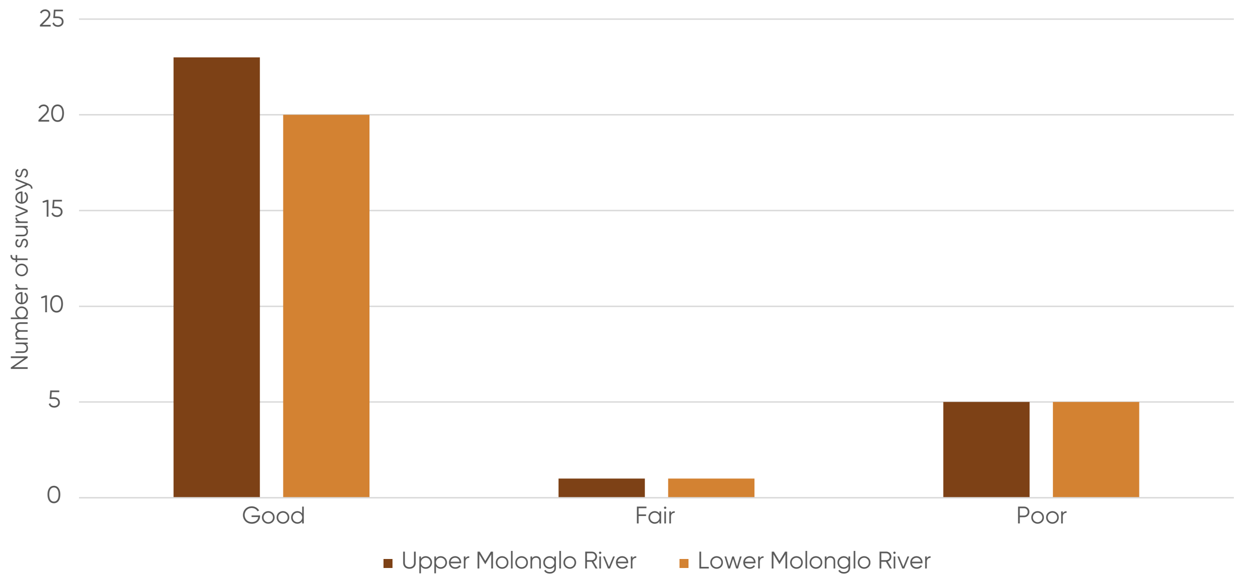



**Figure 7.13.** Macroinvertebrate community health in the upper and lower Molonglo River, 2013 to 2021.

**Data sourced from:** Waterwatch Monitoring Program.

**Note:** Macroinvertebrate condition is derived from adjusted Signal 2.0 scores.

## Riparian condition

The riparian areas of the Molonglo River comprise a mix of native and exotic vegetation. Although much of the riparian habitat has been cleared, the lower Molonglo River is seen as unique with some sections of comparatively significant riparian vegetation. It is also considered to be among the last of the good waterway reaches in the ACT.[155] The comparatively better riparian zones and physical condition of the lower Molonglo River improve the quality of instream habitat. However, the increasing recreational use of the lower Molonglo River's riparian areas is leading to the increased trampling of vegetation along river edges and other disturbances in and around the river, including the spread of terrestrial and aquatic weeds.

Waterwatch undertakes a Rapid Assessment of Riparian Condition (RARC) every two years for sites along the Molonglo River.[156] For the upper Molonglo River, the riparian areas are fringed by exotic and invasive species, with RARC scores showing the riparian zone to be in poor condition, with low quality across all aspects of the vegetation. For the lower Molonglo River, the RARC scores were slightly better with the riparian zone identified as being in fair to poor condition. The better scores for this reach of the river are because of the greater proportion of native vegetation.

155. Alluvium, 2020. *Western Edge Investigation Area – Water Values and Environmental Hydrology Assessment, Technical report prepared for the ACT Government (EPSDD)*. Canberra.
156. O'Reilly, W., et al., 2021. *Catchment Health Indicator Program: Report Card 2020*. Upper Murrumbidgee Waterwatch, Canberra.

## Fish

Knowledge is limited for fish populations in the Molonglo River with no regular survey work undertaken.

Native fish populations in the lower Molonglo River are likely impacted by inappropriate flow regimes and thermal pollution from Scrivener Dam.[157] The lower Molonglo River also receives treated discharges from the Lower Molonglo Water Quality Control Centre (LMWQCC). These discharges are just upstream of the confluence with the Murrumbidgee River at Uriarra and so do not impact on the vast majority of the Molonglo River. However, there is some evidence to suggest that the LMWQCC discharges prevent some native fish species from moving into the Molonglo River from the Murrumbidgee River,[158] with consequences for fish biodiversity in the lower reaches of the Molonglo River.

The ACT Government Conservation Effectiveness Monitoring Program has provided the most recent assessment of fish populations for the upper and lower Molonglo River.[159] The main findings suggest that alien fish species (including European Carp, Eastern Gambusia, Oriental Weatherloach and Redfin Perch) are widespread in the Molonglo River and are likely to have negative effects on water quality and other fish species. However, the lack of monitoring means that any assessment of invasive fish is limited.

The Conservation Effectiveness Monitoring Program also found that Murray Cod and Golden Perch are known to occur upstream and downstream of Lake Burley Griffin. This is likely because of the stocking of these species in Lake Burley Griffin and their subsequent movement upstream and downstream (through dam water releases). It is not known whether these native populations in the lower Molonglo River breed naturally. In addition, threatened Macquarie Perch were translocated into the Molonglo River upstream of Lake Burley Griffin between 2010 and 2018. Surveys have not yet detected the successful establishment of a population from this translocation, although occasional sightings are reported. Western Carp Gudgeon are also known to be present in the Molonglo River upstream and downstream of Lake Burley Griffin.

157. Cheetham, E., Norris, R., and Williams, D., undated. *Recommended environmental flow release scheme for the lower Molonglo River reach*. Report prepared by University of Canberra Institute for Applied Ecology for ACT Planning and Land Authority and ACT Procurement Solutions.
158. Pers Comm, Environment, Planning and Sustainable Development Directorate.
159. Malam, C., et al., 2021. *Conservation Effectiveness Monitoring Program: Aquatic and Riparian Ecosystem Condition Assessment & Monitoring Plan. Technical Report*. Environment, Planning and Sustainable Development Directorate, ACT Government, Canberra.

## Other plants and animals

Platypus are regularly recorded in the Molonglo River below Coppins Crossing during Waterwatch's annual Platypus Month.[160] Water rats (Rakali) and turtles are commonly found in the Molonglo River. Frogwatch surveys have found the number of recorded species to be consistently low in the lower Molonglo River.

Many waterbirds and other birds, including birds of prey, rely on the aquatic and riparian habitats provided by the Molonglo River. Riparian zones in the lower Molonglo River corridor are noted for high bird diversity. More than 200 bird species have been recorded in the ACT and at least three-quarters of these have been recorded in the Molonglo River's riparian zone.[161]

The riparian zones of the lower Molonglo River provide habitat for many species of reptiles. This includes the stony hillsides within riparian zones of the Molonglo River which contain key habitat for the threatened Pink-tailed Worm-lizard (*Aprasia parapulchella*).[162]

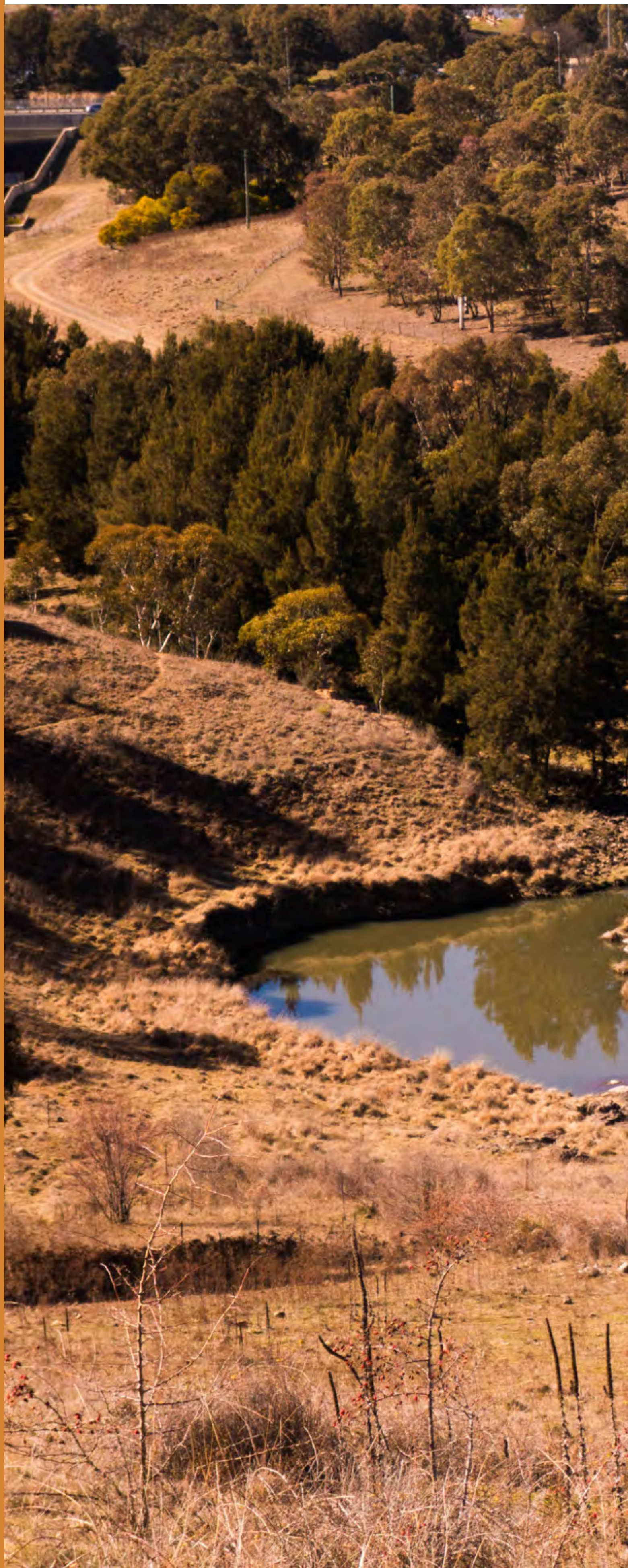
The lower Molonglo River corridor downstream of Coppins Crossing is important habitat for several rare or threatened plants in the ACT, including Pale Pomaderris (*Pomaderris pallida*).

160. O'Reilly, W., et al., 2021. *Catchment Health Indicator Program: Report Card 2020*. Upper Murrumbidgee Waterwatch, Canberra.
161. Based on Canberra Ornithologists Group observations.
162. Environment, Planning and Sustainable Development, 2018. *ACT Aquatic and Riparian Conservation Strategy and Action Plans*. ACT Government, Canberra.

*Molonglo River. Source: Miranda Gardner*

# 7.2 Tuggeranong Creek





*Tuggeranong Creek. Source: Wikimedia Commons*

## 7.2.1 Tuggeranong Creek main findings and key actions

### Condition assessment against management and community values

There is currently no dedicated strategy or specified outcomes for the management of urban waterways in the ACT. Consequently, the values used in this Investigation to assess the state of urban rivers and creeks are based on selected outcomes in the *ACT Water Strategy 2014–44*.[163] These outcomes include the protection and restoration of aquatic ecosystems and for the community to enjoy and have access to healthy waterways. For this assessment, recreational values for urban waterways only relate to activities on lands immediately surrounding the waterbody, they do not include primary contact activities such as swimming. The assessments are informed by the data findings discussed in section **7.2.3 Data trends for Tuggeranong Creek**.

163. Environment and Planning Directorate, 2014. *ACT Water Strategy 2014-44: Striking the balance,* ACT Government, Canberra.

| Value | Status | Condition | Trend | Data quality |
|---|---|---|---|---|
| **TC1:** Is the water quality of Tuggeranong Creek sufficient to support the recreational and aesthetic functions? | **Upstream of Lake Tuggeranong**<br>Because a substantial portion of Tuggeranong Creek and its tributaries upstream of Lake Tuggeranong are concrete lined channels with little surrounding vegetation, they provide poor recreational and visual amenity to the community. The creek is also often full of rubbish which detracts from any possible visual amenity provided by the drains. The high levels of turbidity in the creek further degrade aesthetic values. The continuing urban development in the catchment is increasing water pollution which will further degrade the value of Tuggeranong Creek. | Poor | ↓ | ●●● High |
| | **Downstream of Lake Tuggeranong**<br>Despite the natural creek channel and presence of native riparian tree species, the high turbidity and other water pollutants reduce the recreational and aesthetic value of the lower reaches of the creek. As with the creek reaches upstream of Lake Tuggeranong, the continuing urban development and decreasing water quality in the lake will likely further degrade the creek's recreational and aesthetic values. | Fair | - | ●●● High |
| **TC2:** Does the aquatic health of Tuggeranong Creek support ecological values? | **Upstream of Lake Tuggeranong**<br>Much of Tuggeranong Creek is severely degraded. Upstream of Lake Tuggeranong, the creek is characterised by mostly concrete lined channels with poor water quality and little vegetation. These are almost devoid of ecosystem value because of the highly engineered nature of the waterway. Macroinvertebrate communities are classed as in poor condition above the lake, with the exception of the creek's headwaters which were classed as good condition. Riparian health upstream of the lake is poor to degraded. | Poor | - | ●●○ Moderate |
| | **Downstream of Lake Tuggeranong**<br>Although the downstream reach of the creek has a more natural creek channel with native riparian tree species, the poor water quality impacts on ecosystem health. Macroinvertebrate communities have been classed as significantly to severely impaired in ACT Government surveys, however, Waterwatch assessments found communities in mostly good condition. Riparian health has been classed as poor with an understory dominated by weeds. | Poor | - | ●●○ Moderate |

## Indicator assessment legend

### Condition

- **Good** = Environmental condition is healthy OR pressure likely to have negligible impact on environmental condition/human health/waterbody values.
- **Fair** = Environmental condition is neither positive or negative OR pressure likely to have limited impact on environmental condition/human health/waterbody values.
- **Poor** = Environmental condition is under significant stress, OR pressure likely to have significant impact on environmental condition/human health/waterbody values.
- **Unknown** = Data is insufficient to make an assessment of status and trends.

### Trend

↑ Improving
↓ Deteriorating
- Stable
? Unclear

### Data quality

- ●●● **High** = Adequate high-quality evidence and high level of consensus
- ●●○ **Moderate** = Limited evidence or limited consensus
- ●○○ **Low** = Evidence and consensus too low to make an assessment

## Tuggeranong Creek main findings

### Catchment

- Tuggeranong Creek drains a catchment area of approximately 64 $km^2$.
- Urban areas account for 43 per cent of the catchment and is the dominant land use. Rural areas make up 29 per cent of the catchment, and conservation/recreation land 28 per cent.
- Because a substantial portion of Tuggeranong Creek and its tributaries upstream of Lake Tuggeranong are concrete lined channels, they offer little recreational or visual amenity to the community.

### Flows

- The lack of gauging stations throughout the catchment means that the relative contributions from the tributaries and the influence of the lake on downstream flows are unable to be determined.
- Average annual flow in the lower reaches of the creek is around 10,500 megalitres, which is less than either Ginninderra Creek or Sullivans Creek.

### Water quality

- The concrete lined open drains that characterise much of the creek upstream of Lake Tuggeranong provide no physical or biological value for the improvement of water quality.
- The creek is also often full of rubbish which detracts from any possible visual amenity provided by the drains.
- The continuing urban development in the Tuggeranong District, and especially the construction phase of new suburbs, is increasing water pollutant contributions to the creek and Lake Tuggeranong.
- The high levels of nitrogen, turbidity and electrical conductivity (a measure of salt concentration) is consistent with water in concrete lined drains which degrade water quality.
- The effect of Lake Tuggeranong on the creek's water quality is inconsistent and parameter specific. Although conductivity and dissolved oxygen concentrations are improved by the lake, nitrate concentrations, turbidity and phosphorus concentrations are worse downstream of the lake.

*Phosphorus 2014 to July 2021*

- Phosphorus levels upstream of Lake Tuggeranong met guideline levels for at least 90 per cent of the time, with six of the years assessed recording full compliance. Downstream of the lake, levels were only within the acceptable range for between 80 per cent and 90 per cent of the time.
- Higher concentrations downstream are likely because of other inflows to Lake Tuggeranong which elevate phosphorus concentrations in the water flowing into Tuggeranong Creek downstream.

- Although phosphorus concentrations in Tuggeranong Creek upstream of Lake Tuggeranong were generally within the acceptable range for urban streams, the concentrations were sufficiently high to support cyanobacterial blooms in Lake Tuggeranong.

*Nitrogen 2014 to July 2021*

- Concentrations of nitrogen (as nitrate) upstream of Lake Tuggeranong were consistently outside the acceptable range. There were only two years in which annual samples met guideline levels for at least 80 per cent of the time. For four of the years assessed, compliance with guidelines dropped to 50 per cent or less, with 2020 and 2021 particularly low with just 39 per cent and 23 per cent of samples in the acceptable range.
- Nitrogen concentrations were significantly higher downstream of Lake Tuggeranong. For four of the years assessed, none of the recorded levels were within the acceptable range. For the other years, compliance ranged from just 11 per cent to a high of 60 per cent.
- Higher concentrations downstream are likely because of other inflows to Lake Tuggeranong which elevate nitrogen concentrations in the water flowing into Tuggeranong Creek downstream.

*Turbidity 2011 to July 2021*

- Turbidity levels upstream of Lake Tuggeranong were highly variable with guideline compliance ranging from full compliance to under 50 per cent. From 2015 to 2019, there were considerable periods when the recorded turbidity was well above the acceptable levels. There is no clear reason for this in the records kept for the region but high levels of turbidity may have been caused by local construction work.
- Turbidity levels were significantly higher downstream of Lake Tuggeranong. For six of the years assessed, compliance with guideline levels was just 50 per cent or less and in 2020, compliance fell to just 27 per cent.
- Lake Tuggeranong is not effective at improving the turbidity levels in the downstream Tuggeranong Creek.
- The high turbidity is a concern for the ecosystem health of Tuggeranong Creek and the downstream Murrumbidgee River. It is also the main cause of the poor recreation and aesthetic values associated with the creek.

*Conductivity 2011 to July 2021*

- Electrical conductivity (a measure of salt concentration) upstream of Lake Tuggeranong was consistently outside the acceptable range with six of the years assessed meeting guideline levels for 50 per cent or less of the time.
- Higher conductivity levels for some years may be the result of drier conditions, with the extreme drought period of 2018 and 2019 having particularly low compliance levels of 39 per cent and 28 per cent.
- Conductivity levels were significantly lower downstream of Lake Tuggeranong. For six of the years assessed, compliance with guideline levels was 100 per cent, with other years having around 80 per cent or higher compliance.

- Lake Tuggeranong appears to be effectively mitigating the high conductivity levels flowing into the lake.

*Dissolved oxygen 2011 to July 2021*

- Dissolved oxygen concentrations upstream of Lake Tuggeranong were within acceptable levels for at least 85 per cent of the time for all years assessed.
- Dissolved oxygen concentrations were lower downstream of Lake Tuggeranong, although levels for most years were still within acceptable limits for at least 75 per cent of the time. It is not clear why dissolved oxygen concentrations are lower for some years downstream of the lake.

*pH 2011 to July 2021*

- The levels of pH were generally within the acceptable range for Tuggeranong Creek upstream and downstream of Lake Tuggeranong.

**Biodiversity and ecosystem health**

- The concrete lined channels of Tuggeranong Creek and its major tributaries are almost entirely devoid of value for biodiversity and ecosystem health.
- There is little information on biodiversity and ecosystem health for Tuggeranong Creek apart from macroinvertebrate and riparian assessments. There are no data on fish or other aquatic and riparian species, including for the creek sections with more natural channels.

*Macroinvertebrate communities*

- ACT Government surveys found macroinvertebrate communities downstream of Lake Tuggeranong to be significantly to severely impaired for most assessments over the 2011 to 2021 period. Spring samples were found to have higher numbers of severely impaired communities.
- Waterwatch assessments found macroinvertebrate communities to be in mostly good condition for the upper reach and always poor for the middle reaches that have concrete channels. Downstream of Lake Tuggeranong, the creek's macroinvertebrate communities were mostly found to be in good condition, although poor condition was found for three of the surveys.

*Riparian condition*

- Waterwatch assessments found riparian condition to be poor downstream of Lake Tuggeranong, despite the more natural channel form, because of an understory mostly consisting of weeds. The upper reach in the headwaters was also found to be poor, dominated by weeds and non-native species.
- The concrete lined middle reaches of the creek were found to be degraded being predominantly made up of invasive weed species and mown grass.

### Tuggeranong Creek key actions

Actions for Tuggeranong Creek are to improve monitoring data. These actions are common to all ACT urban waters and are presented in section **11.8 Effectiveness of monitoring, evaluation and reporting processes for urban waters**.

## 7.2.2 Known pressures on the aquatic health of Tuggeranong Creek

This section discusses pressures that are specific to Tuggeranong Creek. For general water quality and aquatic health pressures see section **5.1 Impacts on Canberra's urban lakes and waterways** and **5.2 Monitoring water quality and pollutants** sections.

One of the main pressures on the health of Tuggeranong Creek is the historic legacy of channel modifications which have replaced much of the natural channel with artificially lowered concrete lined open drains. These artificial channels provide no physical or biological value for the improvement of water quality and facilitate the increased concentrations and transport of pollution from urban runoff and other pollutant sources.

The continuing urban development in the Tuggeranong District, and especially the construction phase of new suburbs, is increasing water pollutant contributions to the creek and Lake Tuggeranong. Of particular concern are increased turbidity, sediment and nutrients. The pressures of urban development on the aquatic health are discussed in detail in **Chapter 12: Urban development and the ACT's lakes and waterways**.

### 7.2.3 Data trends for Tuggeranong Creek

This assessment of Tuggeranong Creek incorporates data from four separate sampling locations upstream of Lake Tuggeranong and a single sampling location downstream of the lake. Data is from the Waterwatch program as well as the ACT Government Lakes and Rivers Water quality monitoring program.

For this Investigation, Tuggeranong Creek is divided into two distinct sections – upstream of Lake Tuggeranong, and downstream of the lake to the Murrumbidgee River confluence. It is important that the upper and lower river sections are assessed separately, not just for the differences in channel type and vegetation but also for water quality. This is because Lake Tuggeranong has a significant influence on water quality in the downstream reaches of the creek, trapping some of the pollutants that flow through the lake (see section **6.2 Lake Tuggeranong**).

## Tuggeranong Creek catchment and hydrology

**Catchment**

Tuggeranong Creek begins near the ACT and NSW border east of the Monaro Highway and southeast of the suburb of Theodore. The creek flows north alongside the highway before turning west and travelling through the suburbs of Calwell, Richardson, Isabella Plains and Bonython where it is impounded to form Isabella Pond and then Lake Tuggeranong (Figure 7.14). Downstream of Lake Tuggeranong, the creek flows through the Urambi Hills Nature Reserve and private land before it joins the Murrumbidgee River.

The creek is a concrete lined channel for most of its length (Figure 7.14) with only the small sections upstream of the Monaro Highway and downstream of Lake Tuggeranong retaining natural form. Downstream of Lake Tuggeranong the creek has a more natural form and is fringed by reeds, grassed slopes and casuarina.

Tuggeranong Creek drains a catchment area of approximately 64 $km^2$, flowing through the district of Tuggeranong and into Lake Tuggeranong before flowing west to join the Murrumbidgee River. Urban areas account for 43 per cent of the catchment and are the dominant land use. Rural areas make up 29 per cent of the catchment and conservation/recreation land 28 per cent (Figure 7.15).

**Flows**

A number of tributaries contribute flow to Tuggeranong Creek, including unnamed tributaries through Fadden and Wanniassa which join upstream of Lake Tuggeranong. Kambah Creek and Village Creek flow into Lake Tuggeranong. There is also a complex stormwater network throughout the Tuggeranong suburbs that channel urban runoff into Tuggeranong Creek. A single gauging station operates within the catchment, located on Tuggeranong Creek downstream of Lake Tuggeranong. Flows in this section of the creek are largely determined by the volume of releases from lake. The lack of gauging stations throughout the catchment means that the relative contributions from the tributaries and the influence of the lake on downstream flows are unable to be determined. Average annual flow in the lower reaches of the creek is around 10,500 megalitres, which is less than either Ginninderra Creek or Sullivans Creek.


**Figure 7.14.** Tuggeranong Creek catchment.

**Data sourced from:** ACT Government

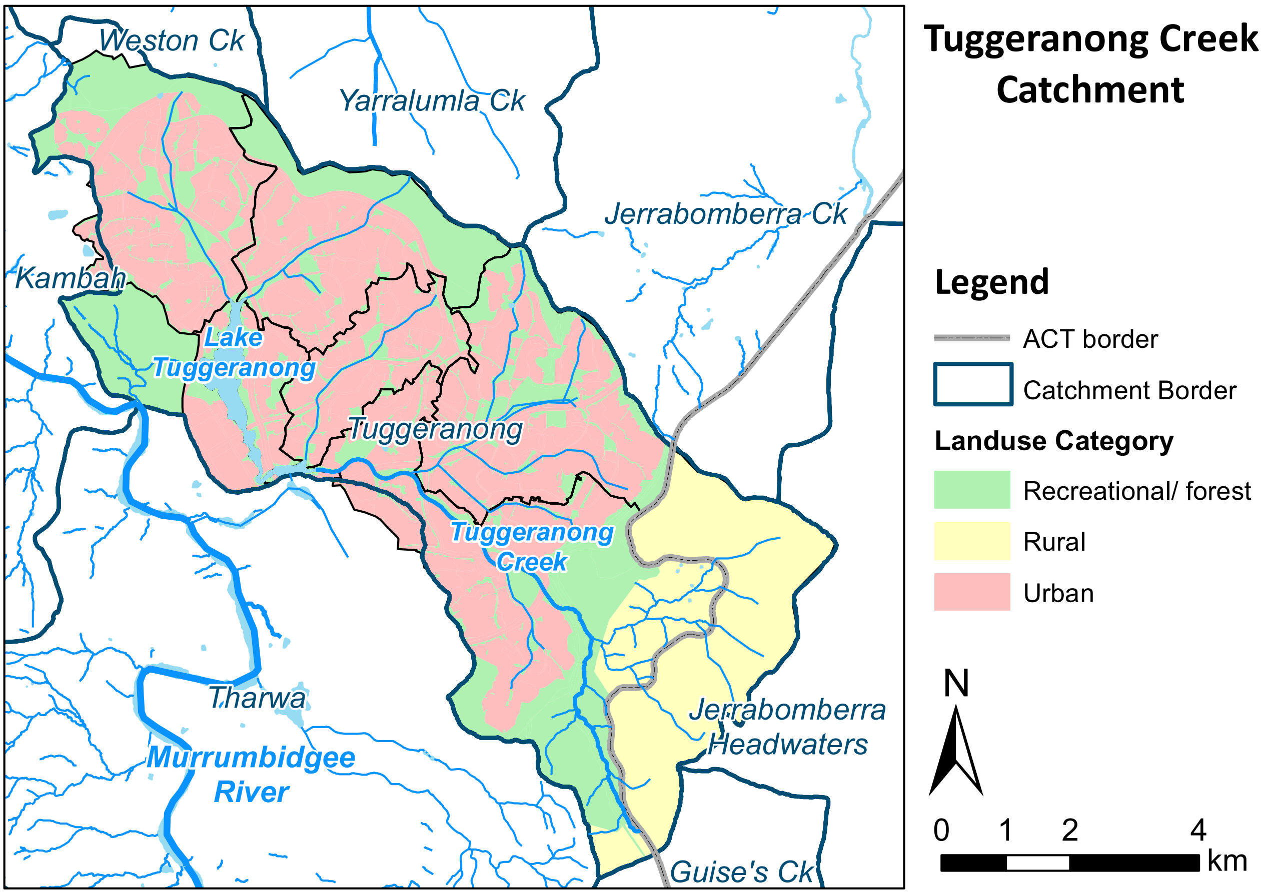



**Figure 7.15.** Tuggeranong Creek catchment and land uses.

**Source:** University of Canberra, Centre for Applied Water Science. Data from ACT Government.

### 7.2.4 Water quality in Tuggeranong Creek

#### Phosphorus

Concentrations of phosphorus in Tuggeranong Creek upstream of Lake Tuggeranong were consistently within the acceptable range. From 2014 to July 2021, annual samples met guideline levels for at least 90 per cent of the time, with six of the years recording total compliance.

Although phosphorus concentrations in Tuggeranong Creek upstream of Lake Tuggeranong were generally within the acceptable range for urban streams, the concentrations were sufficiently high to support cyanobacterial blooms in Lake Tuggeranong.

Phosphorus concentrations were higher downstream of Lake Tuggeranong. For four of the years from 2014 to 2021 recorded levels were only within the acceptable range for 80 per cent to 90 per cent of the time. This is most likely a consequence of the inflows to Lake Tuggeranong from Village Creek and Kambah Creek, as well as other stormwater inputs. These inflows have high nutrient loads which elevate the phosphorus concentrations in the lake water which flows into Tuggeranong Creek downstream (see section **6.2 Lake Tuggeranong**).

Recent research has suggested that the Waterwatch and ACT Government nutrient data may be underestimating the phosphorus concentrations in Tuggeranong Creek.[164] This is supported by the high variation in phosphorus concentrations between Tuggeranong Creek and other urban creeks in the catchment and the significant increase in phosphorus during high rainfall events. Consequently, the mainly low flow sampling conducted for Waterwatch and ACT Government monitoring is likely under-representing the concentrations of nutrients in Tuggeranong Creek.

#### Nitrogen

Concentrations of nitrogen (as nitrate) in Tuggeranong Creek upstream of Lake Tuggeranong were consistently outside the acceptable range. From 2014 to July 2021, there were only two years in which annual samples met guideline levels for at least 80 per cent of the time (Figure 7.16). For four of the years compliance dropped to 50 per cent or less and was particularly low in 2020 and 2021, with just 39 per cent and 23 per cent of samples, respectively, in the acceptable range. The high concentration of nitrogen is, however, consistent with water in concrete lined drains.

164. Ubrihien, R., et al., 2020. *Lake Tuggeranong Research Project Report: Stage 3. A report to the ACT Government from the Centre for Applied Water Science*. University of Canberra, Canberra.

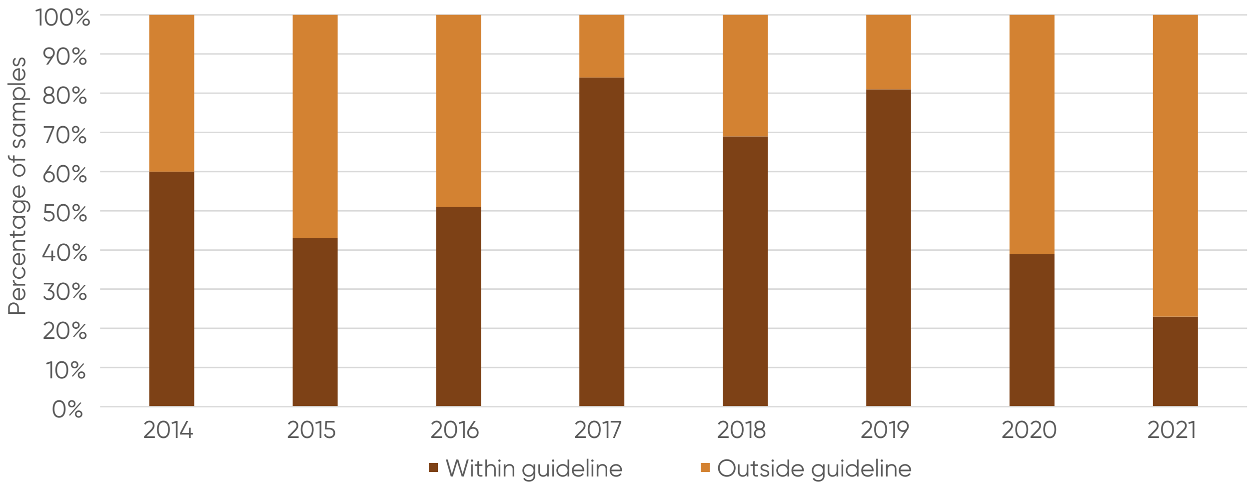



**Figure 7.16.** Annual average of the percentage of nitrate samples within guideline levels in Tuggeranong Creek upstream of Lake Tuggeranong, 2014 to July 2021.
**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

Nitrogen concentrations were significantly higher downstream of Lake Tuggeranong. For four of the years from 2014 to 2021 none of the recorded levels was within the acceptable range (Figure 7.17). For the other years, compliance ranged from just 11 per cent to a high of 60 per cent.

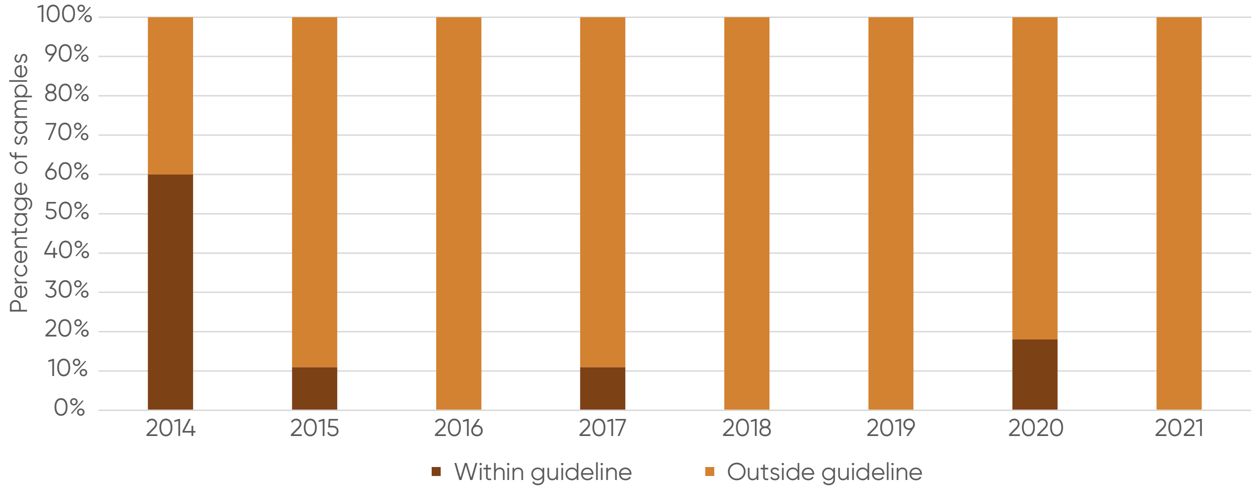



**Figure 7.17.** Annual average of the percentage of nitrate samples within guideline levels in Tuggeranong Creek downstream of Lake Tuggeranong, 2014 to July 2021.
**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

The higher downstream concentrations are most likely a consequence of the inflows to Lake Tuggeranong from Village Creek and Kambah Creek, as well as other stormwater inputs. These inflows have high nutrient loads which elevate the nitrogen concentrations in the lake water which then flows into Tuggeranong Creek downstream (see section **6.2 Lake Tuggeranong**).

It is worth noting urban areas are known to display high nitrogen concentrations with the major causes considered to be leaks in sewerage infrastructure, accumulation of atmospheric deposition on hard surfaces and the subsequent rainfall runoff, fertilisers and groundwater inputs. More investigation is required to determine the causes of high nitrogen concentrations in many of the ACT's urban waterways.

## Turbidity

Turbidity levels in Tuggeranong Creek upstream of Lake Tuggeranong were highly variable but were often outside the acceptable range. From 2011 to July 2021, compliance with guidelines ranged from 100 per cent to under 50 per cent (Figure 7.18). From 2015 to 2019, there were considerable periods when the recorded turbidity was well above the acceptable levels. There is no clear reason for this in the records kept for the region — it may have been caused by local construction work. The level of turbidity in Tuggeranong Creek is generally consistent with water in concrete lined drains.

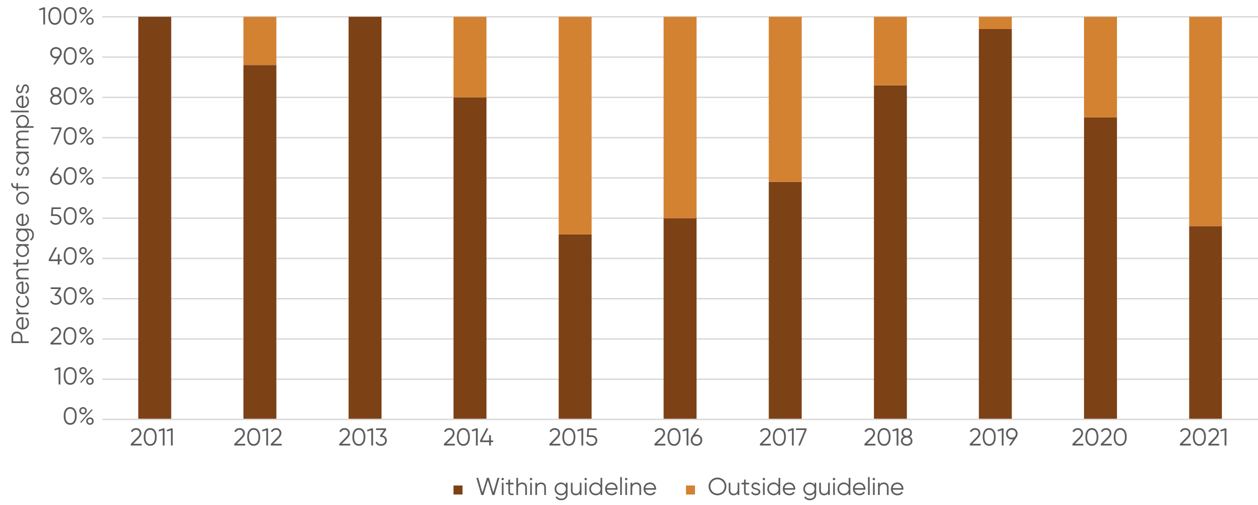



**Figure 7.18.** Annual average of the percentage of turbidity samples within guideline levels in Tuggeranong Creek upstream of Lake Tuggeranong, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

Turbidity levels were significantly higher downstream of Lake Tuggeranong. For six of the years from 2011 to 2021, compliance with guideline levels was 50 per cent or less, and in 2020, compliance fell to just 27 per cent (Figure 7.19). This suggests that Lake Tuggeranong is not effective at improving the turbidity levels in the downstream Tuggeranong Creek.

The high turbidity is a concern for the ecosystem health of Tuggeranong Creek and the downstream Murrumbidgee River. It is also the main cause of the poor recreation and aesthetic values associated with the creek.

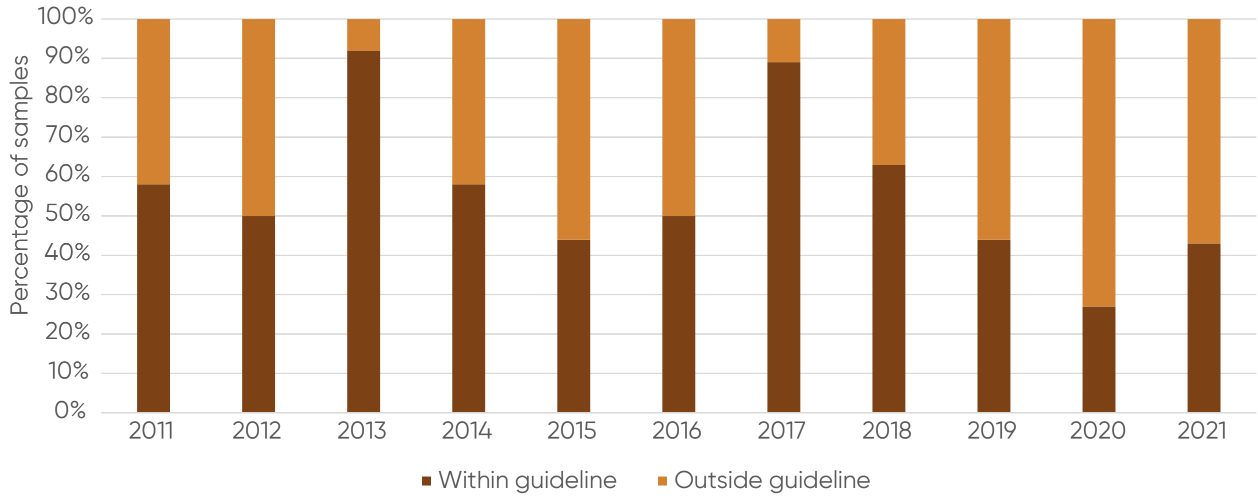



**Figure 7.19.** Annual average of the percentage of turbidity samples within guideline levels in Tuggeranong Creek downstream of Lake Tuggeranong, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

## pH

The levels of pH in Tuggeranong Creek upstream of Lake Tuggeranong were generally within the acceptable range. From 2011 to July 2021, annual samples for all but one year met guideline levels for around 90 per cent or more of the time. There were some occurrences of high readings (pH of 10) during the 2014 sampling period when compliance with guideline levels fell to just 40 per cent. It is not known why this occurred. Tuggeranong Creek downstream of the lake has recorded pH consistently within the acceptable range for at least 90 per cent of the time, with eight years having full compliance.

## Dissolved oxygen

Dissolved oxygen concentrations in Tuggeranong Creek upstream of Lake Tuggeranong were within acceptable levels for at least 85 per cent of the time from 2011 to July 2021; and for at least 75 per cent of the time downstream, with the exception of 2015 when compliance was only 56 per cent.

It is not clear why dissolved oxygen in Tuggeranong Creek is lower for some years downstream of the lake. It may be differences in sampling frequency between 2011 and 2015. Since 2016, the data are far more comparable for Tuggeranong Creek upstream and downstream of the lake. Concentrations of dissolved oxygen are influenced by a range of factors including water temperature, the time of day sampling occurs, and the level of organic matter in the water. This makes it difficult to interpret results.

## Conductivity

Electrical conductivity samples (a measure of salt concentration) in Tuggeranong Creek upstream of Lake Tuggeranong were consistently outside the acceptable range. From 2011 to July 2021, there were six years in which annual samples met guideline levels for 50 per cent or less of the time, and only two years where compliance was more than 80 per cent (Figure 7.20). Higher conductivity levels for some years may be the result of drier conditions, with the extreme drought period of 2018 (39%) and 2019 (28%) having particularly low compliance levels. The high level of electrical conductivity is consistent with water in concrete lined drains.

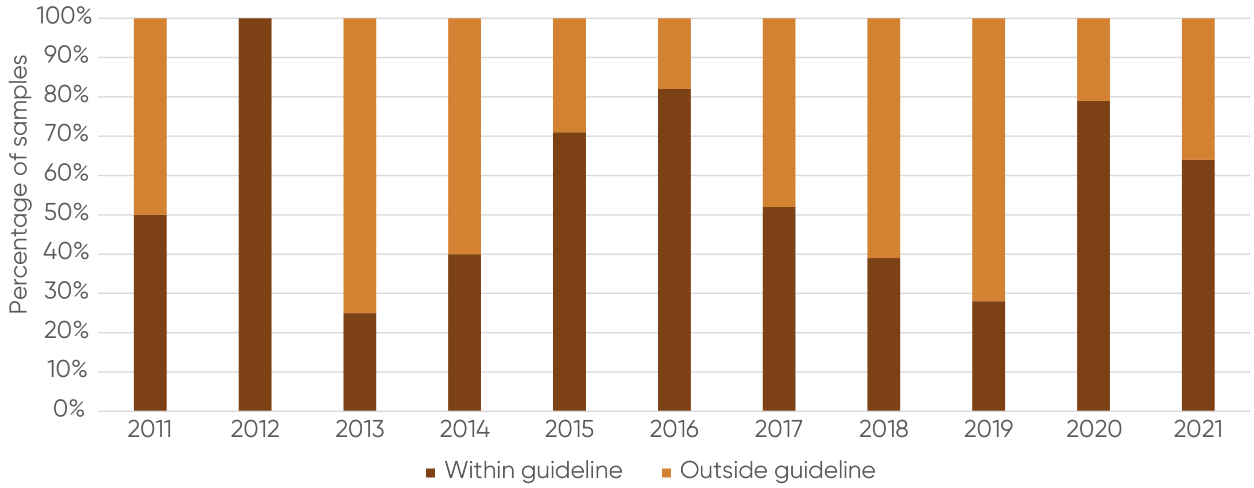



**Figure 7.20.** Annual average of the percentage of electrical conductivity samples within guideline levels in Tuggeranong Creek upstream of Lake Tuggeranong, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

Conductivity levels were significantly lower downstream of Lake Tuggeranong. For six of the years from 2011 to 2021, there was full compliance with guideline levels, with other years having around 90 per cent or higher compliance (Figure 7.21). This suggests that Lake Tuggeranong is effective at mitigating the high conductivity levels flowing into the lake. It may also be that the more natural character of the creek downstream of the lake is reducing conductivity levels.

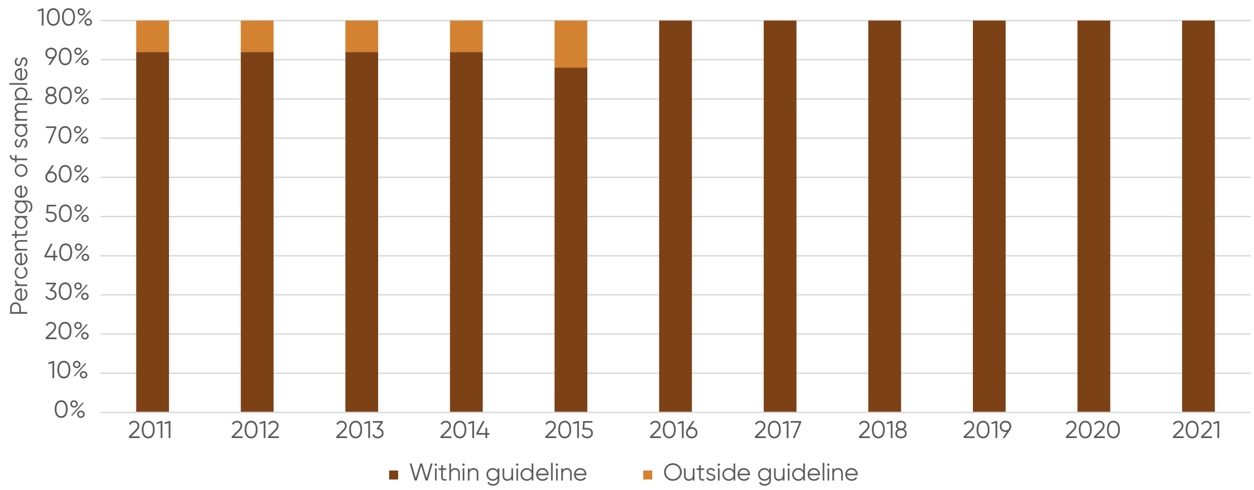



**Figure 7.21.** Annual average of the percentage of electrical conductivity samples within guideline levels in Tuggeranong Creek downstream of Lake Tuggeranong, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

## Biodiversity and ecosystem health

Macroinvertebrate and riparian assessments provide the only measures of biodiversity and ecosystem health for Tuggeranong Creek. There are no data on native fish or other aquatic and riparian species, including for the creek sections with more natural channels. However, it is accepted that the concrete lined channels of Tuggeranong Creek and its major tributaries are almost entirely devoid of value for biodiversity and ecosystem health.

## Macroinvertebrate communities

ACT Government monitoring of the macroinvertebrate communities in Tuggeranong Creek occurs at a single site downstream of Lake Tuggeranong, with surveys are usually taken in the spring and autumn of each year.

Results show that macroinvertebrate communities were typically significantly to severely impaired over the 2011 to 2021 period. Although the spring surveys had higher numbers of severely impaired communities (Figure 7.22), the surveys also indicate significant variation – ranging from severely impaired to very close to excellent condition from 2018 to 2020. This suggests that there have been seasonal changes in the quality of water and/or habitat, but that the effects are not consistent across years.

The autumn macroinvertebrate survey data were consistently classed as significantly impaired for all but one year. Although there has been an improvement in the autumn macroinvertebrate communities over the past 10 years, likely driven by an improvement in dissolved oxygen concentrations in the creek, there has also been a decline in turbidity and nutrient concentrations.

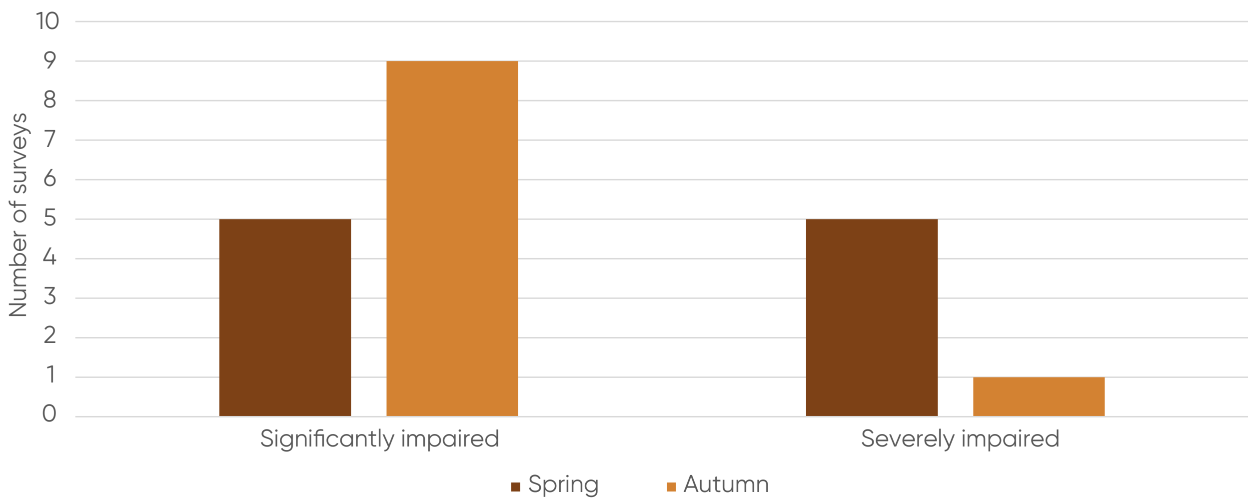



**Figure 7.22**. Macroinvertebrate community health in Tuggeranong Creek downstream of Lake Tuggeranong, 2011 to 2021.

**Data sourced from:** Environment, Planning and Sustainable Development Directorate.

**Note:** Macroinvertebrate condition is derived from the Australian River Assessment System classifications.

Waterwatch surveys macroinvertebrates at three sites, two upstream of Lake Tuggeranong in the upper and middle reaches, and one site downstream of the lake.[165] Surveys are taken annually in autumn and spring.

Upstream of Lake Tuggeranong, Waterwatch surveys found the macroinvertebrate communities to be in mostly good condition but always poor for the middle reaches that have concrete channels (Figure 7.23). This poor condition is attributed to both the lack of habitat and the impacts on water quality from pollutants such as turbidity and nitrogen which are frequently outside of the acceptable range. Downstream of Lake Tuggeranong, the creek's macroinvertebrate communities were mostly found to be in good condition, although poor condition was found for three of the surveys.

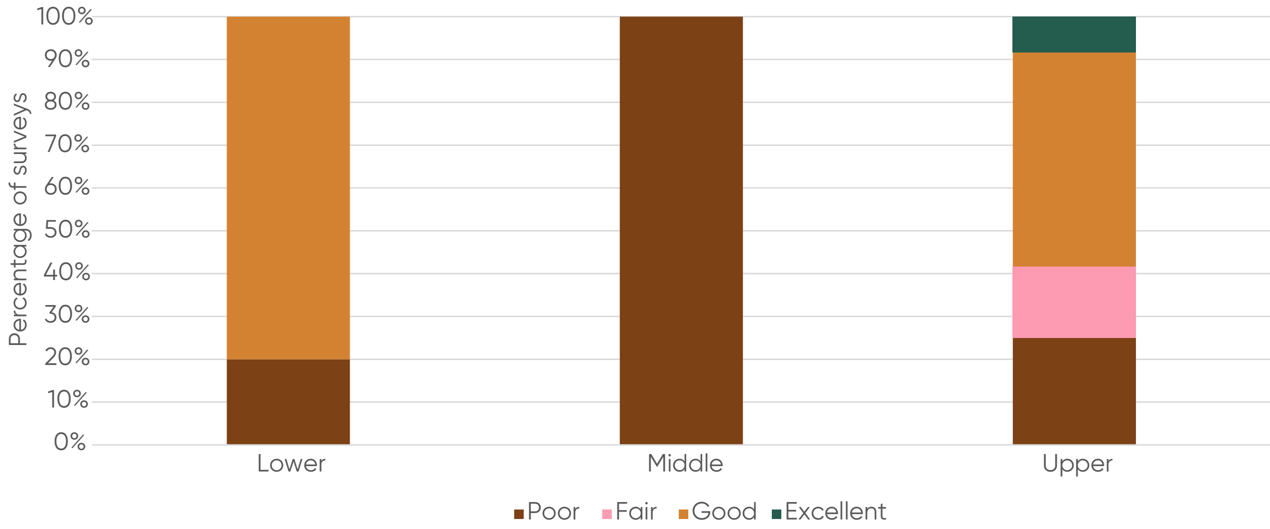



**Figure 7.23.** Macroinvertebrate community health in the upper, middle and lower reaches of Tuggeranong Creek, 2014 to 2021.

**Data sourced from:** Waterwatch Monitoring Program.

**Notes:** Macroinvertebrate condition is derived from adjusted Signal 2.0 scores. The upper and middle reaches are upstream of Lake Tuggeranong, the lower reach is downstream of the lake.

## Riparian condition

Waterwatch undertakes a Rapid Assessment of Riparian Condition (RARC) every two years for the upper, middle and lower reaches of Tuggeranong Creek.[166] For the lower reach downstream of Lake Tuggeranong, riparian condition was found to be poor despite the more natural channel form fringed by reeds, grassed slopes and casuarina. The poor condition is a result of an understory mostly consisting of weeds. The upper reach in the headwaters was also found to be poor, dominated by weeds and non-native species. Unsurprisingly, the concrete lined middle reaches of Tuggeranong Creek were found to be degraded being predominantly made up of invasive weed species and mown grass.

165. O'Reilly, W., et al., 2021. *Catchment Health Indicator Program: Report Card 2020*. Upper Murrumbidgee Waterwatch, Canberra.
166. Ibid

# 7.3 Ginninderra Creek



*Ginninderra Creek. Source: Ryan Colley*

### 7.3.1 Ginninderra Creek main findings and key actions

#### Condition assessment against management and community values

There is currently no dedicated strategy or specified outcomes for the management of urban waterways in the ACT. Consequently, the values used in this Investigation to assess the state of urban rivers and creeks are based on selected outcomes in the *ACT Water Strategy 2014–44*.[167] These outcomes include the protection and restoration of aquatic ecosystems, and for the community to enjoy and have access to healthy waterways. For this assessment, recreational values for urban waterways only relate to activities on lands immediately surrounding the waterbody, they do not include primary contact activities such as swimming. The assessments are informed by the data findings discussed in section **7.3.3 Data Trends for Ginninderra Creek**.

167. Environment and Planning Directorate, 2014. *ACT Water Strategy 2014–44: Striking the balance*. ACT Government, Canberra.

| Value | Status | Condition | Trend | Data quality |
|---|---|---|---|---|
| **GC1:** Is the water quality of Ginninderra Creek sufficient to support the recreational and aesthetic functions? | The natural channels provide improved recreational and aesthetic value to the community, compared to the open concrete drains of many urban waterways. However, high levels of turbidity in the creek degrade recreational and aesthetic values. Ongoing urban development in the catchment will likely continue to impact on turbidity levels in the creek. | Fair | - | ●●● High |
| **GC2:** Does the aquatic health of Ginninderra Creek support ecological values? | Poor water quality results in some of Ginninderra Creek's reaches for dissolved oxygen, nitrogen and conductivity, and especially the often highly turbid water, make it challenging for healthy aquatic ecosystems to flourish in Ginninderra Creek. Riparian condition has been assessed as poor for all but the most downstream reach. ACT Government macroinvertebrate communities have been assessed as significantly to severely impaired, and more than 30 per cent of Waterwatch surveys have found macroinvertebrate communities to be in poor condition. Fish populations are known to be dominated by invasive species. | Poor | - | ●●○ Moderate |

## Indicator assessment legend

### Condition

- **Good** = Environmental condition is healthy OR pressure likely to have negligible impact on environmental condition/human health/waterbody values.
- **Fair** = Environmental condition is neither positive or negative OR pressure likely to have limited impact on environmental condition/human health/waterbody values.
- **Poor** = Environmental condition is under significant stress, OR pressure likely to have significant impact on environmental condition/human health/waterbody values.
- **Unknown** = Data is insufficient to make an assessment of status and trends.

### Trend

- ↑ Improving
- ↓ Deteriorating
- - Stable
- ? Unclear

### Data quality

- ●●● High = Adequate high-quality evidence and high level of consensus
- ●●○ Moderate = Limited evidence or limited consensus
- ●○○ Low = Evidence and consensus too low to make an assessment

## Ginninderra Creek main findings

### Catchment

- Ginninderra Creek drains a catchment area of approximately 224 $km^2$.
- It comprises a mix of urban (34%), rural (30%) and conservation/recreation land uses (36%).

### Flows

- The lack of gauging stations throughout the catchment means that the relative contributions from the tributaries and the influence of Lake Ginninderra on downstream flows are unable to be determined.
- The average annual flow upstream of Lake Ginninderra (near the Barton Highway) is around 7,000 megalitres per year. Downstream of the lake near Charnwood Road, the average annual flow is around 15,000 megalitres per year. Annual flows are highly variable ranging from as low as 99 megalitres to more than 39,000 megalitres recorded in 2021.

### Water quality

*Phosphorus 2014 to July 2021*

- Concentrations of phosphorus recorded in Ginninderra Creek upstream and downstream of Lake Ginninderra were nearly always within the acceptable range.

*Nitrogen 2014 to July 2021*

- Concentrations of nitrogen (as nitrate) were consistently outside the acceptable range, regardless of location.
- For creek sections upstream of Lake Ginninderra, compliance with guideline levels ranged from a minimum of 7 per cent in 2012 to a maximum of 61 per cent in 2014. Compliance was worse downstream of the lake, ranging from 0 per cent in 2014 to a high of just 33 per cent in 2015.

*Turbidity 2011 to July 2021*

- Turbidity levels in Ginninderra Creek were consistently outside the acceptable range, regardless of location.
- For creek sections upstream of Lake Ginninderra, compliance with guideline levels ranged from a minimum of 8 per cent in 2013 to a maximum of 70 per cent in 2017.
- There has been some improvement in the upstream turbidity levels since 2014, which may reflect changes in the location of urban development.
- Whilst turbidity levels were generally better downstream of the lake for most years, there was also much variation in compliance with guideline levels ranging from 0 per cent in 2011 to 63 per cent in 2017 and 2021.
- The higher levels of turbidity upstream of Lake Ginninderra may be caused by runoff from the urban development that has been occurring in the upper catchment over the past 10 years. The downstream improvements in turbidity are likely to be in part caused by the trapping of sediment and mitigation of turbidity in Lake Ginninderra

*pH 2011 to July 2021*

- pH levels recorded in Ginninderra Creek upstream and downstream of Lake Ginninderra were 100 per cent compliant with guideline levels.

*Dissolved oxygen 2011 to July 2021*

- Dissolved oxygen concentrations in Ginninderra Creek upstream of Lake Ginninderra were within acceptable levels for 80 per cent or more of the time. Compliance was higher upstream of the lake than for downstream for all but two of the years assessed.
- In the reaches downstream of Lake Ginninderra, dissolved oxygen concentrations only attained around 80 per cent compliance with guidelines for three of the reported years, with most years showing a compliance of 70 per cent or less.
- Low concentrations of dissolved oxygen downstream of Lake Ginninderra may be caused by a high organic load in the creek, possibly from the leaf fall of deciduous trees that line the creek in sections.

*Conductivity 2011 to July 2021*

- Electrical conductivity samples (a measure of salt concentration) in Ginninderra Creek upstream of Lake Ginninderra were consistently outside the acceptable range, only meeting guideline levels for around 70 per cent of the time.
- Conductivity was improved downstream of Lake Ginninderra with six of the years reported having a 90 per cent compliance with guideline levels and other years having around 80 per cent or higher compliance.
- Differences observed for conductivity levels upstream and downstream of Lake Ginninderra are likely the result of runoff from the urban development that has been occurring in the upper catchment over the past 10 years.
- It is highly likely that conductivity is much higher in the upper reaches of Ginninderra Creek than that recorded downstream of the Gungahlin and Yerrabi Ponds which would likely mitigate the impacts of development upstream.
- Both the upstream and downstream reaches of Ginninderra Creek have seen an increase in the number of high conductivity readings in the past five years, although the reasons for this are not clear.

## Biodiversity and ecosystem health

- The poor water quality results in some of Ginninderra Creek's reaches for dissolved oxygen, nitrogen and conductivity, and especially the often highly turbid water, would make it challenging for healthy aquatic ecosystems to flourish in Ginninderra Creek.

*Macroinvertebrates*

- ACT Government assessments of macroinvertebrate communities from 2011 to 2021 found mostly significantly to severely impaired communities over the assessment period, this is likely in response to the quality of the urban runoff and the degraded in-stream and riparian habitat.

- Waterwatch assessments from 2014 to 2021 found the macroinvertebrate communities of Ginninderra Creek to be mostly in good condition for reaches upstream and downstream of Lake Ginninderra. However, more than 30 per cent of the assessments for both upstream and downstream reaches found macroinvertebrate communities to be in poor condition.
- The differences in results between the ACT Government and Waterwatch monitoring of the macroinvertebrate communities is likely because of site variation and methodology. It is recommended that the two programs be better integrated to inform the management of the creeks.

*Riparian condition*

- Waterwatch assessments found riparian condition to be poor for all Ginninderra Creek reaches except for the Ginninderra Falls to Murrumbidgee River reach which was found to be fair. Although this reach has the best riparian habitat along Ginninderra Creek, surveys found very little vegetation regeneration. The rest of the Ginninderra Creek riparian zone is dominated by weeds, non-native species and grass.

*Fish*

- Although knowledge is limited for fish populations in Ginninderra Creek with no regular survey work undertaken, the creek is known to be dominated by invasive species including European Carp, Eastern Gambusia, Oriental Weatherloach and Redfin Perch.
- Murray Cod and Golden Perch are known to occur upstream and downstream of Lake Ginninderra. This is likely because of the native fish stocking in Lake Ginninderra and the Yerrabi and Gungahlin Ponds. It is unlikely that these populations breed naturally in Ginninderra Creek.
- There was one native fish kill reported for Ginninderra Creek which occurred between Gungahlin Pond and Lake Ginninderra in 2020. More than 50 Murray Cod and Golden Perch were killed by disease likely resulting from bank clearing and dredging to improve stormwater flow. This event shows the importance of minimising the waterway impacts of any channel or riparian works undertaken.

## Ginninderra Creek key actions

That the ACT Government:

**Key Action 7.4:** Institute a monitoring program (water quality and biological monitoring) in the upper reaches of Ginninderra Creek to improve knowledge on the ecosystem health in the headwaters of the creek, and to enable a comprehensive assessment of the water quality management performance of the Gungahlin and Yerrabi Ponds.

**Key Action 7.5:** Investigate the reasons for the increase in the number of high conductivity readings in Ginninderra Creek.

Other actions for Ginninderra Creek are to improve monitoring data. These actions are common to all ACT urban waters and are presented in section **11.8 Effectiveness of monitoring, evaluation and reporting processes for urban waters**.

### 7.3.2 Known pressures on the aquatic health of Ginninderra Creek

This section discusses pressures that are specific to Ginninderra Creek. For general water quality and aquatic health pressures see sections **5.1 Impacts on Canberra's urban lakes and waterways** and **5.2 Monitoring water quality and pollutants**.

Increasing urban development across the Ginninderra Creek catchment over the past 15–20 years, particularly in Gungahlin, has had negative impacts on the creek. It has led to an increased load of pollutants and litter entering the creek. The high sediment loads generated by development are a significant issue and are often accompanied by high levels of water turbidity, nitrogen concentrations and conductivity (a measure of salt concentration), as well as low concentrations of dissolved oxygen. These water quality issues make it challenging to maintain the health of aquatic ecosystems. With urban development continuing in the catchment, pressures on water quality and aquatic health will increase. The pressures of urban development on aquatic health are discussed in detail in **Chapter 12: Urban development and the ACT's lakes and waterways**.

### 7.3.3 Data trends for Ginninderra Creek

This assessment of Ginninderra Creek incorporates four sampling locations upstream of Lake Ginninderra and seven downstream, all sites are on the main stem of the creek. Data is from the Waterwatch program as well as the ACT Government Lakes and Rivers Water Quality Monitoring Program. The data are presented separately for the upstream and downstream reaches of Ginninderra Creek because Lake Ginninderra influences downstream water quality by trapping some pollutants (see section **6.3 Lake Ginninderra**).

There is a lack of data for the upper reaches of Ginninderra Creek, with the most upstream monitored site being below the Gungahlin and Yerrabi Ponds (see Figure 7.24). This means it is not possible to determine water quality and ecosystem health in the headwaters. This data gap is considered to be a significant issue for the management of Ginninderra Creek and Lake Ginninderra.

#### Ginninderra Creek catchment and hydrology

**Catchment**

Ginninderra Creek is a partly perennial stream that begins near the northern boundary of the ACT in the Mulligan's Flat Nature Reserve (see Figure 7.24). In contrast to many other urban waterways, including the Tuggeranong and Sullivans Creeks, Ginninderra Creek retains a relatively natural channel form rather than being concrete lined to manage stormwater runoff. The creek drains a catchment area of approximately 224 km$^2$, flowing in a south-westerly direction through Gungahlin and Belconnen before flowing west to join the Murrumbidgee River in NSW.[168]

The catchment comprises a mix of urban (34%), rural (30%) and conservation/recreation land uses (36%) (Figure 7.25.). It is reported that more than 40  per cent of ACT residents live in the catchment of Ginninderra Creek.[169]

168. Note that the majority of documentation written about Ginninderra Creek states a catchment area of 320 km$^2$. This investigation has been unable to reproduce this number based on the mapping analysis undertaken. The data used for this investigation suggests a catchment area of around 224 km$^2$.
169. O'Reilly, W., et al., 2021. *Catchment Health Indicator Program: Report Card 2020*. Upper Murrumbidgee Waterwatch, Canberra.

*Water and reeds. Source: Miranda Gardner*

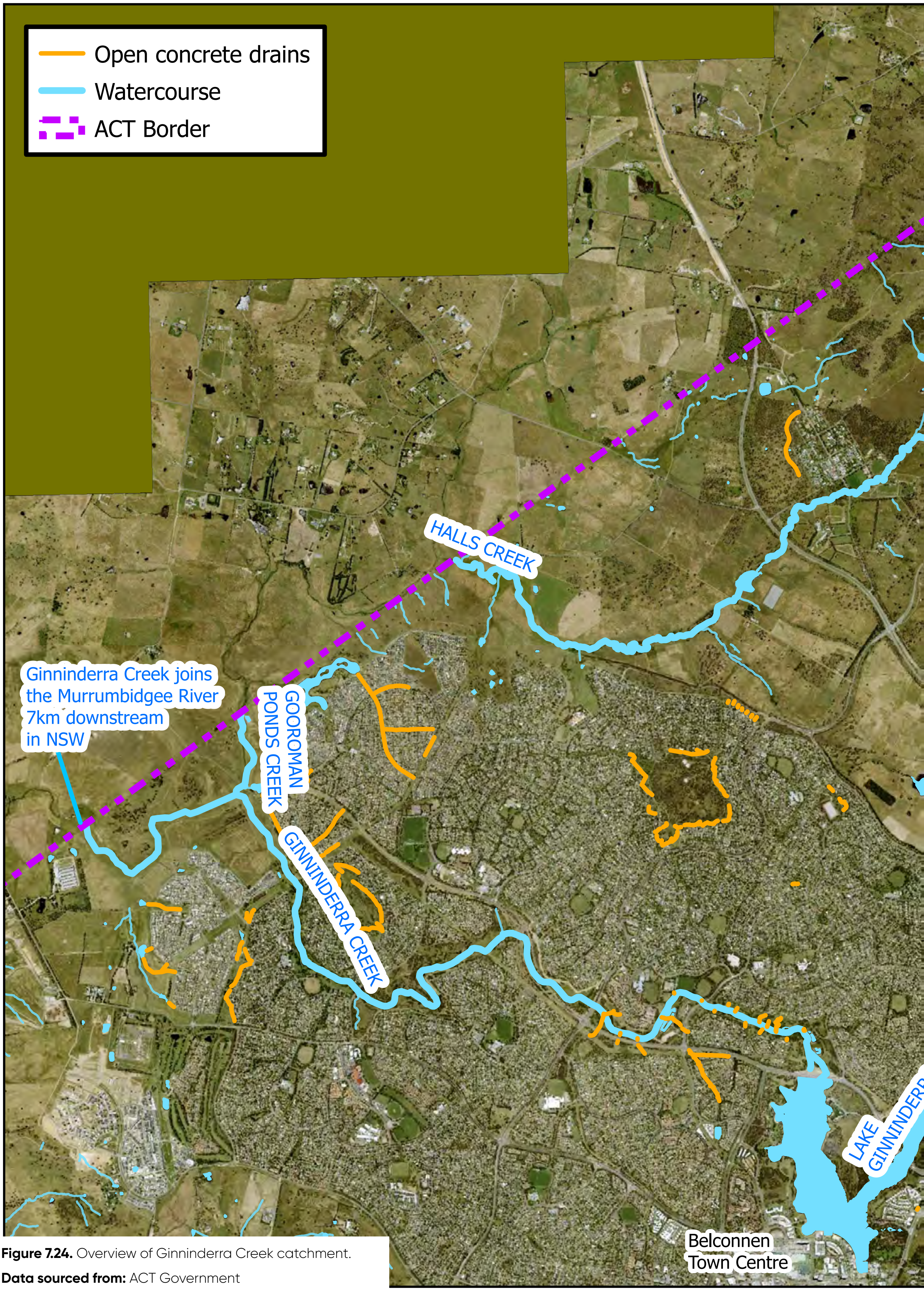
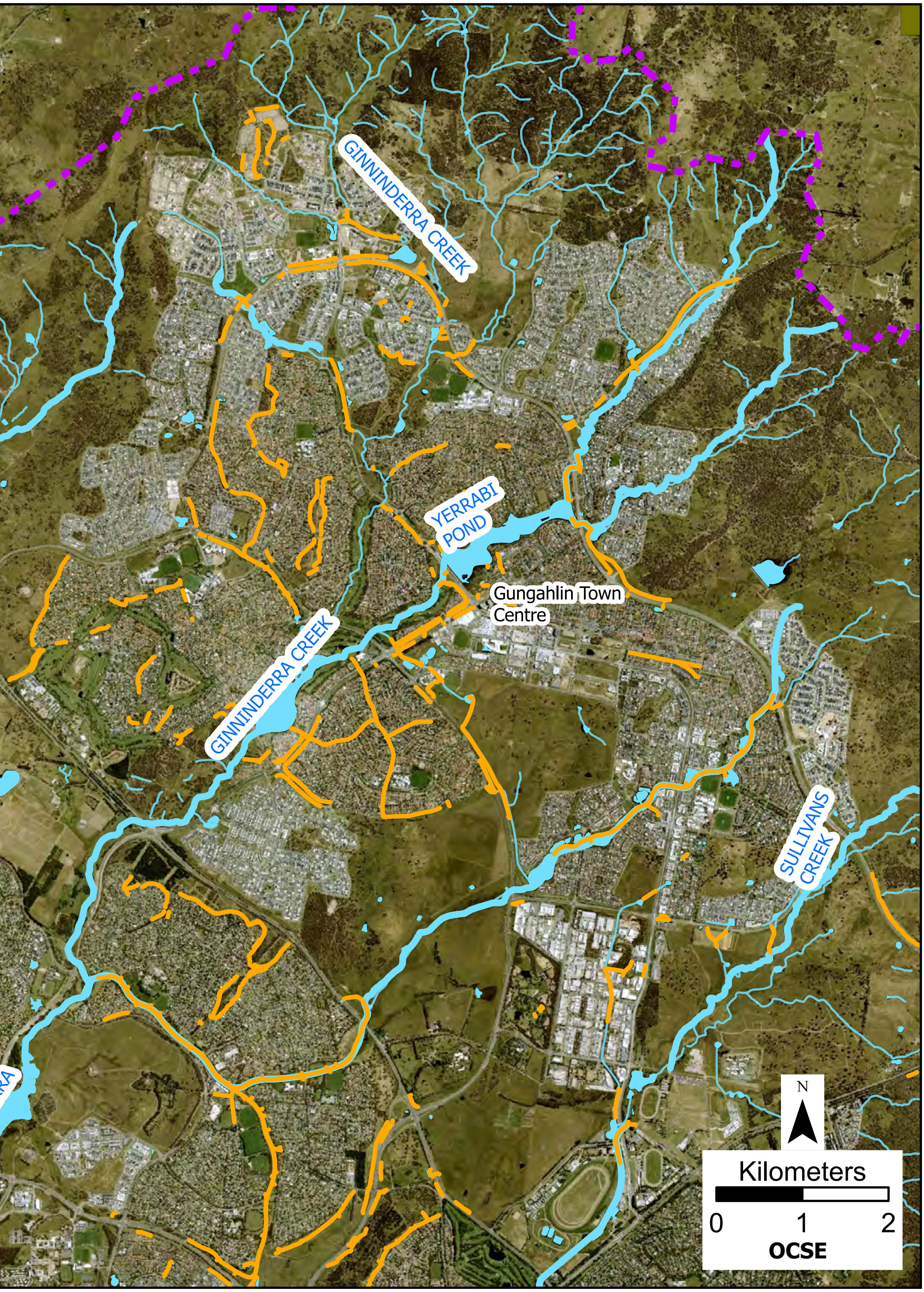



**Figure 7.24.** Overview of Ginninderra Creek catchment.

**Data sourced from:** ACT Government


GINNINDERRA CREEK
YERRABI POND
Gungahlin Town Centre
GINNINDERRA CREEK
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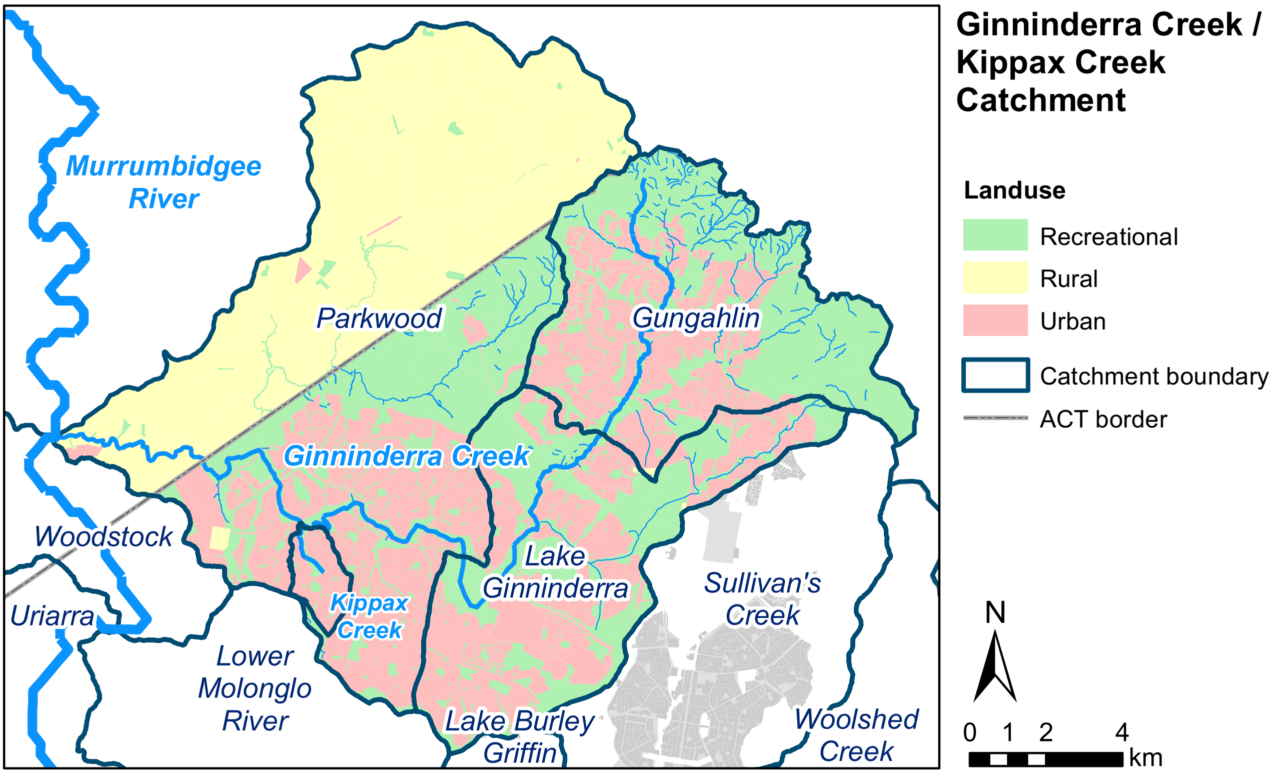



**Figure 7.25.** Ginninderra Creek catchment and land uses.

**Source:** University of Canberra, Centre for Applied Water Science. Data from ACT Government.

### Flows

Several named tributaries contribute flow to Ginninderra Creek including Gooromon Ponds Creek, Gold Creek, Gungaderra Creek, Cow Flat Creek and Bedulluck Creek. Given the position of the gauging stations, it is not possible to determine the relative contributions from the different tributaries.

The average annual flow upstream of Lake Ginninderra (near the Barton Highway) is around 7,000 megalitres but is highly variable with a high flow of 35,100 megalitres recorded in 2021 and as little as 99 megalitres in 1980. Downstream of the lake near Charnwood Road, the average annual flow is around 15,000 megalitres but is also highly variable with a high flow of more than 39,000 megalitres recorded in 2021 and only 4,000 megalitres in 1994.

Flow data suggests an increase in annual flows from 2010 onwards which may be a result of the urban development in the upper catchment.

### 7.3.4 Water quality in Ginninderra Creek

#### Phosphorus

From 2014 to July 2021, concentrations of phosphorus recorded in Ginninderra Creek upstream and downstream of Lake Ginninderra were nearly always within the acceptable range (guideline levels). For both upstream and downstream reaches, all but two years had 100 per cent compliance with guideline levels. For those years where full compliance was not achieved, more than 95 per cent of samples met guideline levels.

#### Nitrogen

Concentrations of nitrogen (as nitrate) in Ginninderra Creek were consistently outside the acceptable range from 2014 to July 2021, regardless of location. It is also clear that nitrogen concentrations are higher downstream of Lake Ginninderra.

Upstream of Lake Ginninderra, compliance with guideline levels ranged from a minimum of 7 per cent in 2012 to a maximum of 61 per cent in 2014 (Figure 7.26). Compliance was worse downstream of the lake, ranging from 0 per cent in 2014 to a high of just 33 per cent in 2015 (Figure 7.27).

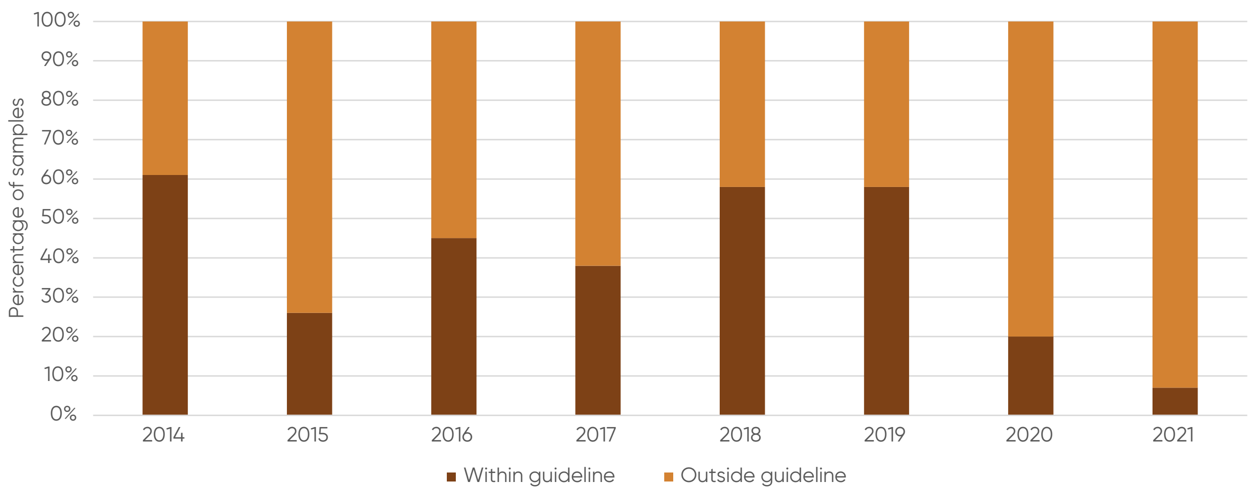



**Figure 7.26.** Annual average of the percentage of nitrate samples within guideline levels in Ginninderra Creek upstream of Lake Ginninderra, 2014 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

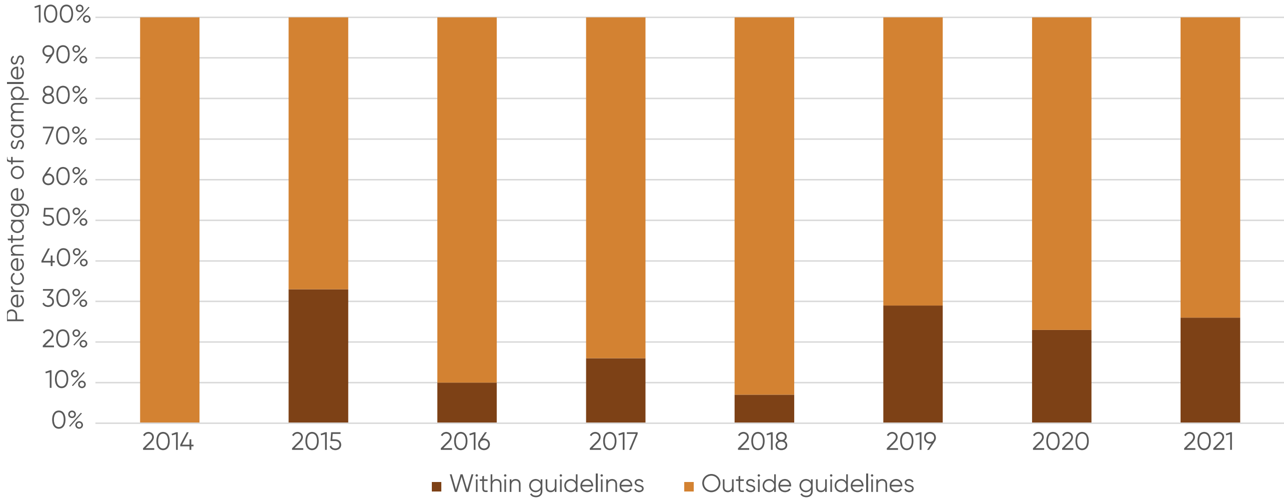



**Figure 7.27.** Annual average of the percentage of nitrate samples within guideline levels in Ginninderra Creek downstream of Lake Ginninderra, 2014 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

It is not clear what is driving the high nitrogen concentrations downstream of Lake Ginninderra, with the nitrogen concentrations frequently outside of the acceptable range for the majority of the urban creek monitoring locations. Urban areas are known to display high concentrations of nitrate in the waterways and the major causes are thought to be sewage leaks, accumulation of atmospheric deposition on hard surfaces and the subsequent rainfall runoff, fertilisers and groundwater inputs. It is unlikely that the higher concentrations downstream of Lake Ginninderra are caused by the lake itself, especially as levels in the lake are usually lower than those in Ginninderra Creek (see section **6.3 Lake Ginninderra**). More investigation is required to determine the causes of high nitrogen concentrations in many of the ACT's urban waterways.

## Turbidity

Turbidity levels in Ginninderra Creek were consistently outside the acceptable range from 2011 to July 2021, regardless of location. Although there was slight improvement downstream of Lake Ginninderra.

For creek sections upstream of Lake Ginninderra, compliance with guideline levels ranged from a minimum of 8 per cent in 2013 to a maximum of 70 per cent in 2017 (Figure 7.28). There has been some improvement in the upstream turbidity levels since 2014, which may reflect changes in the location of urban development in relation to the sampling locations.

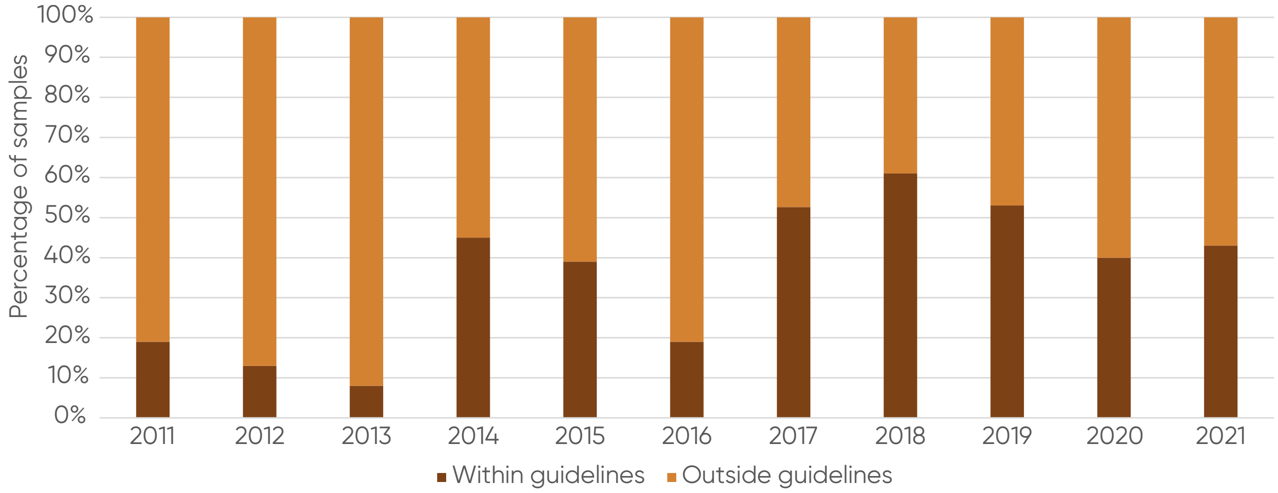



**Figure 7.28.** Annual average of the percentage of turbidity samples within guideline levels in Ginninderra Creek upstream of Lake Ginninderra, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

Compliance was generally better downstream of the lake in most years but also showed high variation ranging from 0 per cent in 2011 to a 63 per cent in 2017 and 2021 (Figure 7.29).

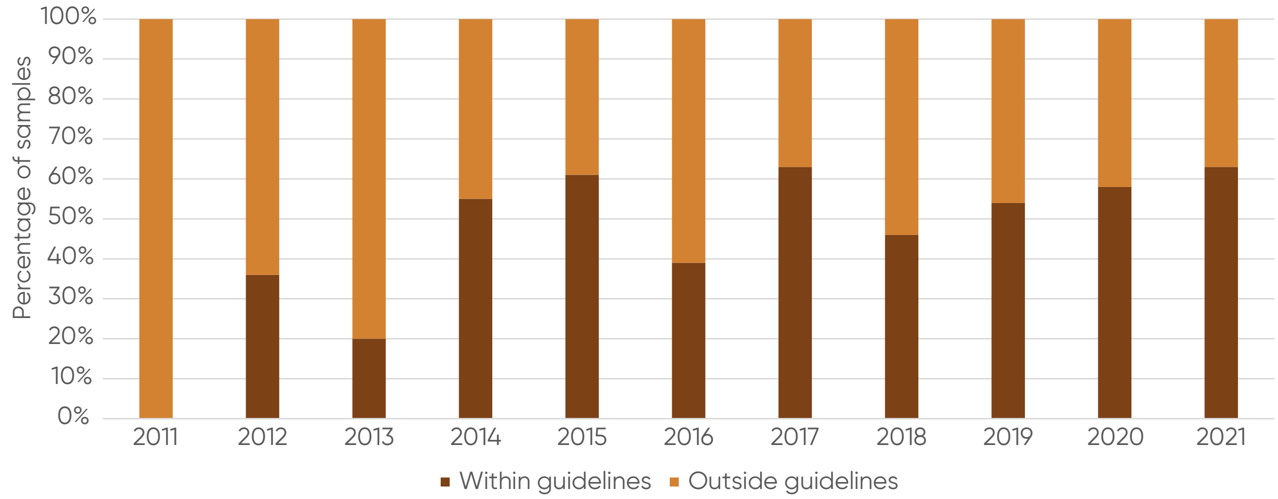



**Figure 7.29.** Annual average of the percentage of turbidity samples within guideline levels in Ginninderra Creek downstream of Lake Ginninderra, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

The higher levels of turbidity in Ginninderra Creek upstream of Lake Ginninderra may be caused by runoff from the urban development that has been occurring in the upper catchment over the past 10 years. The downstream improvements are likely to be in part caused by the trapping of sediment and mitigation of turbidity by Lake Ginninderra (see section **6.3 Lake Ginninderra**).

## pH

From 2011 to July 2021, pH levels recorded in Ginninderra Creek upstream and downstream of Lake Ginninderra were 100 per cent compliant with guideline levels.

## Dissolved oxygen

From 2011 to July 2021, dissolved oxygen concentrations in Ginninderra Creek upstream of Lake Ginninderra were within acceptable levels for 80 per cent or more of the time (Figure 7.30). Upstream compliance was higher than compliance downstream of the lake for most years.

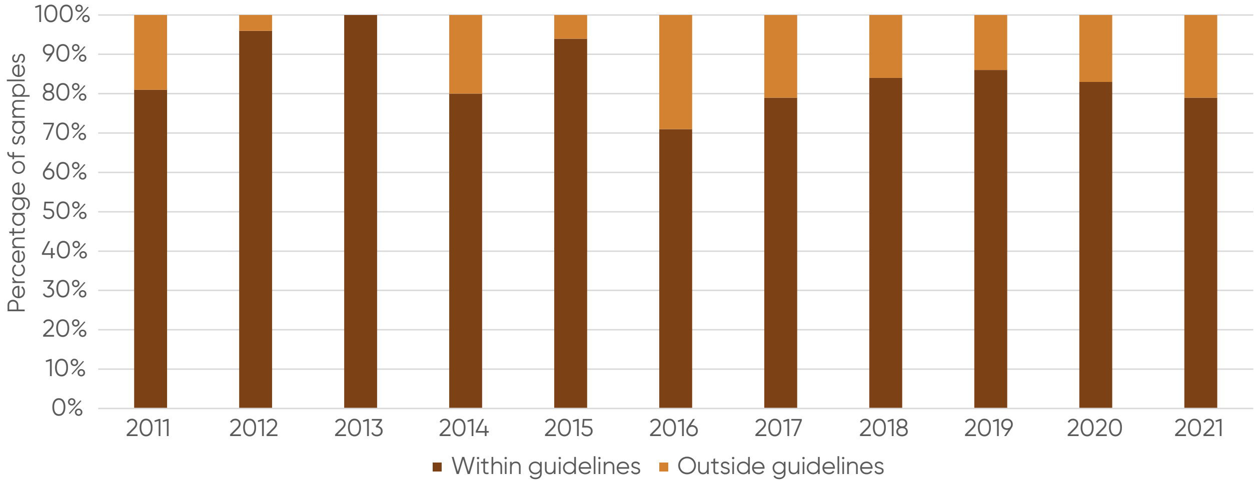



**Figure 7.30.** Annual average of the percentage of dissolved oxygen samples within guideline levels in Ginninderra Creek upstream of Lake Ginninderra, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

In the reaches downstream of Lake Ginninderra, dissolved oxygen concentrations only attained around 80 per cent compliance with guidelines for three of the reported years, with most years showing a compliance of 70 per cent or less (Figure 7.31). Downstream compliance was less than that for upstream for all but two years.

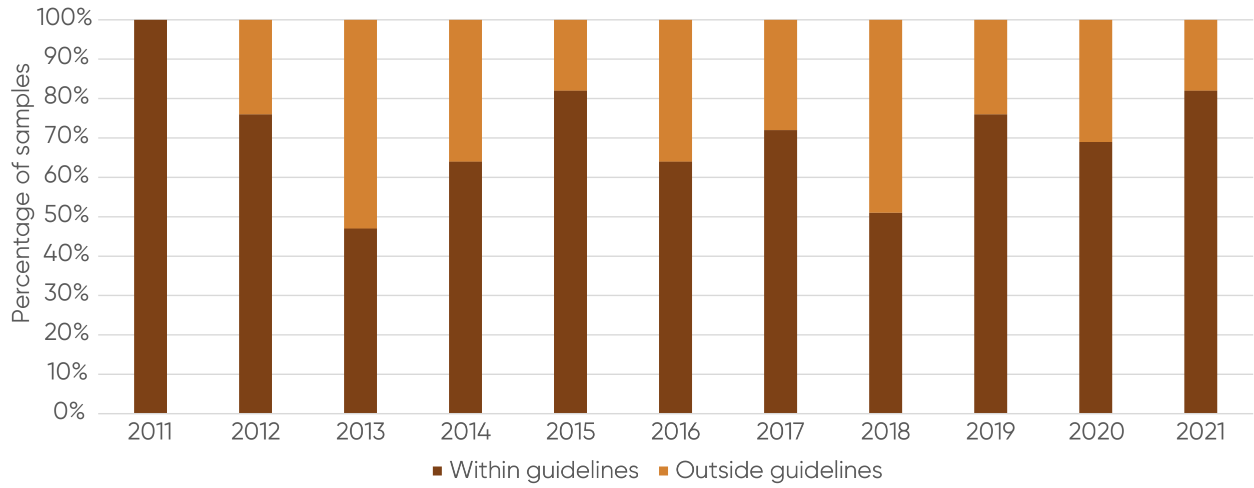



**Figure 7.31.** Annual average of the percentage of dissolved oxygen samples within guideline levels in Ginninderra Creek downstream of Lake Ginninderra, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

Low concentrations of dissolved oxygen downstream of Lake Ginninderra may, in part, be caused by a high organic load in the creek, possibly from the leaf fall of deciduous trees that line the creek in sections. High organic loads increase the biological oxygen demand and reduce the dissolved oxygen concentrations in the creek waters. Concentrations of dissolved oxygen are also influenced by other factors including water temperature and the time of day sampling occurs. This can make it difficult to interpret results.

## Conductivity

From 2011 to July 2021, electrical conductivity samples (a measure of salt concentration) in Ginninderra Creek upstream of Lake Ginninderra were frequently outside the acceptable range, although they met guideline levels for around 70 per cent or more of the time (Figure 7.32).

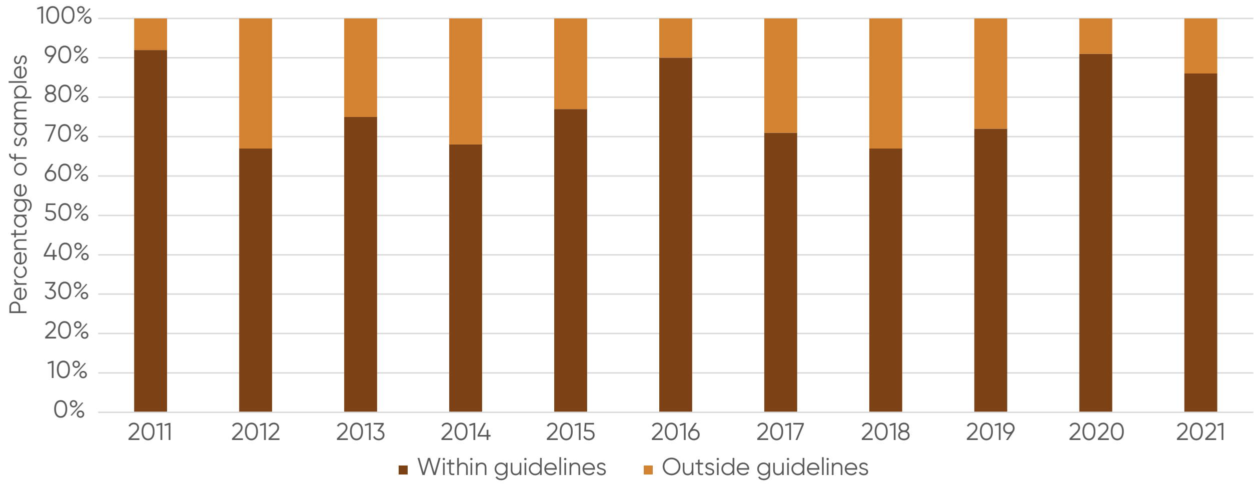



**Figure 7.32.** Annual average of the percentage of electrical conductivity samples within guideline levels in Ginninderra Creek upstream of Lake Ginninderra, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

Conductivity levels were improved downstream of Lake Ginninderra. For six of the years reported, compliance with guideline levels was 90 per cent or higher with other years having around 80 per cent or higher compliance (Figure 7.33).

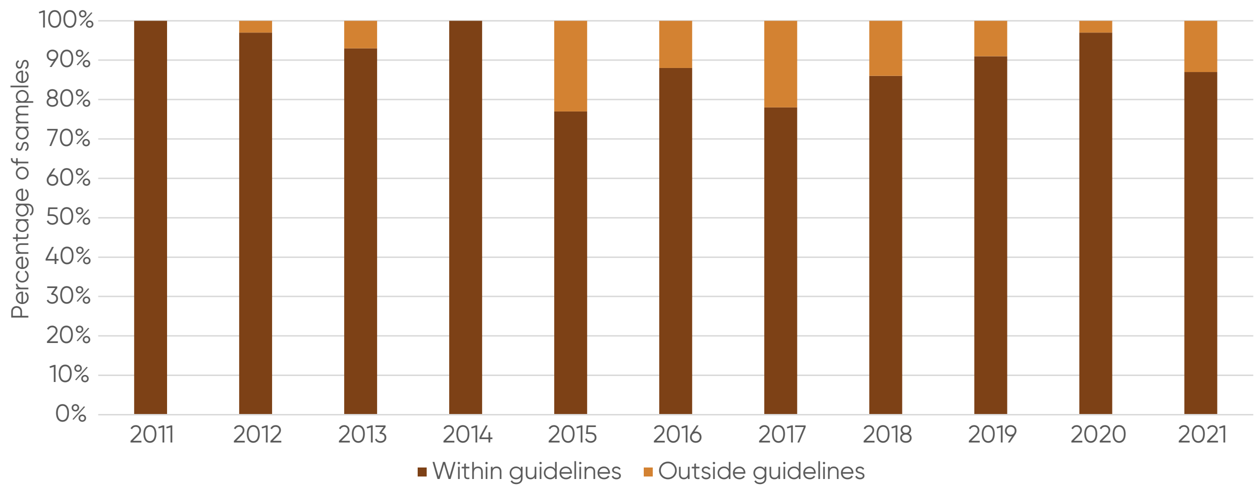



**Figure 7.33.** Annual average of the percentage of electrical conductivity samples within guideline levels in Ginninderra Creek downstream of Lake Ginninderra, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water quality monitoring program.

It is likely that the differences observed for Ginninderra Creek upstream and downstream of Lake Ginninderra result from differences in the character of the runoff from the local areas, rather than any effect of the lake. For example, higher levels of conductivity upstream of the lake may be caused by runoff from the urban development that has been occurring in the upper catchment over the past 10 years. It is also highly likely that conductivity is much higher in the upper reaches of Ginninderra Creek than that recorded for the monitoring sites which are downstream of the Gungahlin and Yerrabi Ponds. These ponds would be expected to mitigate the effects of development, improving the downstream water quality for most pollutants.

Both the upstream and downstream reaches of Ginninderra Creek have seen an increase in the number of high conductivity readings in the past five years, although the reasons for this are not clear. It is possible that very dry conditions may have contributed to these values from 2017 to 2019, but this would not explain the higher values in 2015 and 2016. It is also possible that the changes in catchment urbanisation have been sufficient to result in an increase in high conductivity readings, but the more noticeable change has been downstream of Lake Ginninderra which has had less urban development over this period. More investigation is required to determine the causes of high nitrogen concentrations in many of the ACT's urban waterways.

## Biodiversity and ecosystem health

Macroinvertebrate and riparian assessments provide the only measures of biodiversity and ecosystem health for Ginninderra Creek. There are no data on native fish or other aquatic and riparian species, although Waterwatch surveys do report the presence of waterbird species and Eastern Water Dragons in some reaches.[170]

Poor water quality results in some of the creek's reaches for dissolved oxygen, nitrogen and conductivity, and especially the often highly turbid water, would make it challenging for healthy aquatic ecosystems to flourish in Ginninderra Creek.

## Macroinvertebrate communities

ACT Government monitoring of the macroinvertebrate communities in Ginninderra Creek occurs at two sites downstream of Lake Ginninderra, and one site upstream of the lake. Macroinvertebrate surveys are usually taken in the spring and autumn of each year.

Results show that macroinvertebrate communities were typically significantly to severely impaired over the 2011 to 2021 period (Figure 7.34). This is not dissimilar to other monitored creeks in the urban areas of Canberra and is most likely in response to the quality of the urban runoff and the degraded in-stream and riparian habitat. The data also show that the spring macroinvertebrate community tended to be more impaired than the autumn community, reasons for this are not clear.

170. Ibid

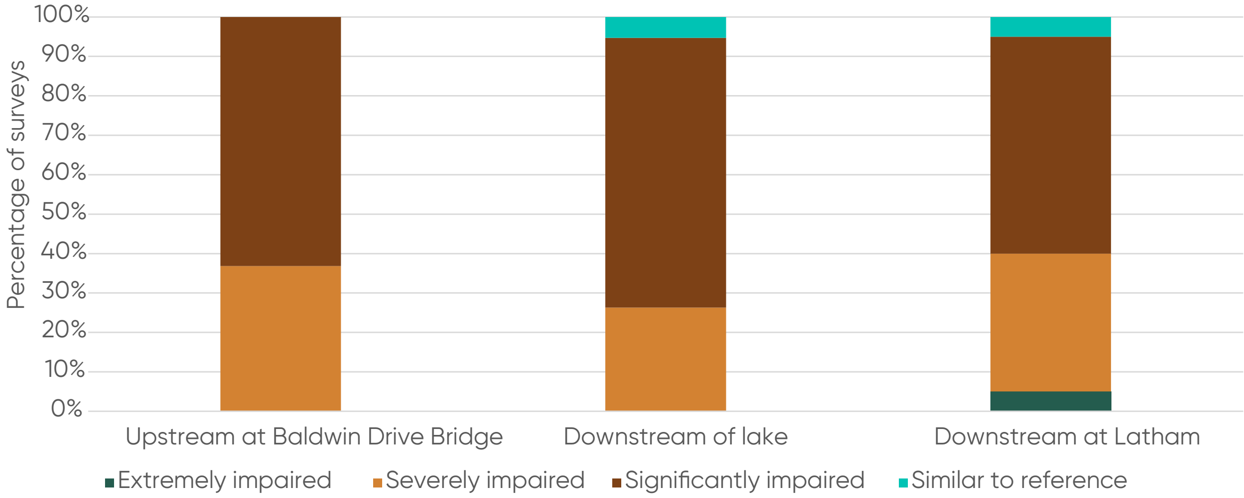



**Figure 7.34.** Macroinvertebrate community health in Ginninderra Creek upstream and downstream of Lake Ginninderra, 2011 to 2021.

**Data sourced from:** Environment, Planning and Sustainable Development Directorate.

**Note:** Macroinvertebrate condition is derived from the Australian River Assessment System classifications.

Waterwatch surveys macroinvertebrates at 13 sites in Ginninderra Creek, five upstream of Lake Ginninderra, and eight downstream of the lake.[171]

Waterwatch assessments from 2014 to 2021 found the macroinvertebrate communities of Ginninderra Creek to be mostly in good condition for reaches upstream and downstream of the lake (Figure 7.35). However, more than 30 per cent of the assessments, both upstream and downstream, found macroinvertebrate communities to be in poor condition. There were good and poor condition results for each sampling site, and in the spring and autumn surveys. These mixed results suggest that macroinvertebrate communities are responding to variations in water quality and habitat condition in Ginninderra Creek.

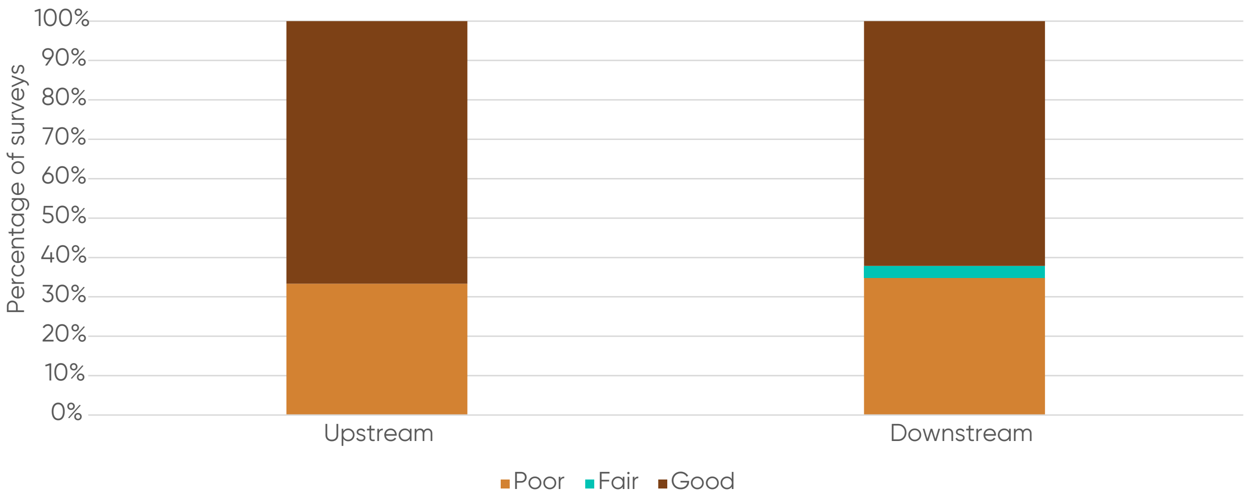



**Figure 7.35.** Macroinvertebrate community health in Ginninderra Creek upstream and downstream of Lake Ginninderra, 2014 to 2021.

**Data sourced from:** Waterwatch Monitoring Program.

**Notes:** Macroinvertebrate condition is derived from adjusted Signal 2.0 scores.

171. Ibid

There are some differences between the results of the ACT Government macroinvertebrate monitoring and that conducted by Waterwatch. This is likely because of site variation and methodology. It is recommended that the two programs should be better integrated to inform the management of the creeks.

## Riparian condition

Waterwatch undertakes a Rapid Assessment of Riparian Condition in Ginninderra Creek every two years.[172] The riparian condition was found to be poor for all reaches except for the Ginninderra Falls to Murrumbidgee River reach which was found to be fair. Although this reach has the best riparian habitat along Ginninderra Creek including mature casuarinas and gum trees, surveys found very little vegetation regeneration. The rest of the Ginninderra Creek riparian zone is dominated by weeds, non-native species and grass.

## Fish

Knowledge is limited for fish populations in Ginninderra Creek with no regular survey work undertaken. Fish populations are known to be dominated by invasive species including European Carp, Eastern Gambusia, Oriental Weatherloach and Redfin Perch. These invasive species have negative effects on water quality and other fish species.

Murray Cod and Golden Perch are also known to occur upstream and downstream of Lake Ginninderra. This is likely because of the native fish stocking in Lake Ginninderra and the Yerrabi and Gungahlin Ponds, and the subsequent movement of stocked fish upstream, and also downstream through water releases. It is unlikely these populations breed naturally in Ginninderra Creek.

There was one native fish kill reported for Ginninderra Creek which occurred between Lake Ginninderra and the Gungahlin Pond in 2020. More than 50 Murray Cod and Golden Perch were killed by disease likely resulting from bank clearing and dredging to improve stormwater flow. This event shows the importance of minimising the waterway impacts of any channel or riparian works undertaken.

172. Ibid

*Eastern Longnecked Turtle. Source: Ryan Colley*

# 7.4 Sullivans Creek



*Sullivan's Creek in ANU. Source: Ben Dyer*

### 7.4.1 Sullivans Creek main findings and key actions

#### Condition assessment against management and community values

There is currently no dedicated strategy or specified outcomes for the management of urban waterways in the ACT. Consequently, the values used in this Investigation to assess the state of urban rivers and creeks are based on selected outcomes in the *ACT Water Strategy 2014–44*.[173] These outcomes include the protection and restoration of aquatic ecosystems and for the community to enjoy and have access to healthy waterways. For this assessment, recreational values for urban waterways only relate to activities on lands immediately surrounding the waterbody, they do not include primary contact activities such as swimming. The assessments are informed by the data findings discussed in section **7.4.3 Data Trends for Sullivans Creek.**

Water quality data for the upper and middle reaches of Sullivans Creek are too limited to be confidently used to assess condition and trends. Consequently, this assessment is limited to the lower reach which is not a true representation of the main creek system. Therefore, conclusions drawn below cannot be used to determine the overall state of Sullivans Creek.

173. Environment and Planning Directorate, 2014. *ACT Water Strategy 2014-44: Striking the balance*. ACT Government, Canberra.

| Value | Status | Condition | Trend | Data quality |
|---|---|---|---|---|
| **SC1:** Is the water quality of Sullivans Creek sufficient to support the recreational and aesthetic functions? | **Lower reach only**<br>Despite the absence of concrete channels in the lower reach of the creek, high levels of turbidity and other pollutants often degrade recreational and aesthetic values. There are also large volumes of rubbish observed in Sullivans Creek and its wetlands, as well as occasional odours, which detract from recreational and aesthetic values. | Fair | - | ●●● High |
| **SC2:** Does the aquatic health of Sullivans Creek support ecological values? | **Lower reach only**<br>Poor water quality results for nutrients, turbidity and dissolved oxygen make it challenging for healthy aquatic ecosystems to flourish in Sullivans Creek. Riparian condition has been assessed as fair to poor. Macroinvertebrate communities have been assessed as fair to good, despite the poor water quality. Fish populations are known to be dominated by invasive species. | Poor | - | ●●○ Moderate |

## Indicator assessment legend

### Condition

- **Good** = Environmental condition is healthy OR pressure likely to have negligible impact on environmental condition/human health/waterbody values.
- **Fair** = Environmental condition is neither positive or negative OR pressure likely to have limited impact on environmental condition/human health/waterbody values.
- **Poor** = Environmental condition is under significant stress, OR pressure likely to have significant impact on environmental condition/human health/waterbody values.
- **Unknown** = Data is insufficient to make an assessment of status and trends.

### Trend

- ↑ Improving
- ↓ Deteriorating
- \- Stable
- ? Unclear

### Data quality

- ●●● **High** = Adequate high-quality evidence and high level of consensus
- ●●○ **Moderate** = Limited evidence or limited consensus
- ●○○ **Low** = Evidence and consensus too low to make an assessment

## Sullivans Creek lower reach main findings

**Catchment**

- The Sullivans Creek catchment covers an area of 52.4 $km^2$ and has a north–south length of 12 km.
- The catchment comprises a mix of conservation/recreation (47 per cent), urban (43 per cent) and rural (10 per cent) land uses. The catchment in the middle and lower reaches of Sullivans Creek is dominated by urban land.

**Flows**

- None of the Sullivans Creek tributaries are gauged which means it is not possible to determine the relative contributions to the main creek.
- The average annual flow in Sullivans Creek is between 2,000 megalitres at Lyneham (Southwell Park) and slightly more than 5,000 megalitres at the Australian National University (Barry Drive). This makes it the smallest (by flow) of the four urban creek systems evaluated for this Investigation.

**Water quality**

*Phosphorus 2014 to July 2021*

- Concentrations of total phosphorus in the lower reaches of Sullivans Creek were consistently outside the acceptable range with some very high concentrations recorded.
- Annual compliance with guidelines ranged from only 12 per cent to a maximum of 75 per cent of samples taken. Typically, more than 50 per cent of annual samples exceeded the acceptable range.
- The high phosphorus concentrations are likely because of the greatly modified catchment and aquatic ecosystems in the creek.
- The limited data available for the middle reach of the creek suggests that high concentrations of phosphorus are also an issue for the highly urbanised and concrete lined areas.

*Nitrogen 2015 to July 2021*

- Concentrations of nitrogen (as nitrate) in the lower reaches of Sullivans Creek were consistently outside the acceptable range with some high concentrations recorded. However, compliance was higher than for phosphorus.
- Annual compliance with guidelines ranged from 25 per cent to a maximum of 88 per cent of samples taken. For all but one year, more than 55 per cent of annual samples were within the acceptable range.

*Turbidity 2011 to July 2021*

- Turbidity levels in the lower reaches of Sullivans Creek were consistently outside the acceptable range.
- Annual compliance with guidelines ranged from just 17 per cent to a maximum of 66 per cent of samples taken, with eight years over the reported period having around 50 per cent or more of samples exceeding guideline levels.

- Sources of high turbidity are most likely caused by sediment transported by rainfall runoff from urban areas and developments. Another driver of high turbidity is the amount of fine organic content in the creek from the large loads of organic matter from urban areas.

*pH 2011 to July 2021*

- pH recordings in Sullivans Creek were always within the acceptable range.

*Dissolved oxygen 2014 to July 2021*

- Concentrations of dissolved oxygen in the lower reaches of Sullivans Creek were consistently outside the acceptable range with some very low concentrations recorded.
- Annual compliance with guidelines ranged from 0 per cent in 2015 to a maximum of 57 per cent of samples taken. Typically, around 45 per cent to 60 per cent of annual samples were within the acceptable range.
- Low concentrations of dissolved oxygen in Sullivans Creek may, in part, be caused by a high organic load in the creek, possibly from the leaf fall of deciduous trees that line the creek in sections.

*Conductivity 2011 to July 2021*

- Electrical conductivity samples (a measure of salt concentration) in Sullivans Creek were sometimes outside the acceptable range. However, annual conductivity samples did meet guideline levels for around 70 per cent or more of the time in all but two of the years reported.
- Elevated levels of conductivity are consistent with water in concrete lined drains which make up a significant length of the creek's channel upstream of the sites sampled.

## Biodiversity and ecosystem health

*Macroinvertebrates 2014 to 2021*

- Waterwatch surveys undertaken in the lower Sullivans Creek have found macroinvertebrate communities to be in a fair to good condition.
- Currently, there is insufficient data to assess the condition of macroinvertebrate communities in the upper and middle reaches of Sullivans Creek. The concrete lined channels upstream of the lower Sullivans Creek reaches are almost entirely devoid of value for biodiversity and ecosystem health.

*Riparian condition*

- The riparian areas of the middle and lower reaches of Sullivans Creek are highly managed, typically comprising grasses, reeds and a scattered mixture of native and exotic trees. Most of the remnant native vegetation was removed by land clearing for agriculture and in the process of converting the creek to concrete channels.
- Waterwatch has found the lower Sullivans Creek riparian condition to be fair to poor.

*Fish*

- Fish populations are known to be dominated by invasive species including European Carp, Eastern Gambusia, Oriental Weatherloach and Redfin Perch.
- Waterwatch surveys of the lower Sullivans Creek have noted that the native Western Carp Gudgeon are common.

It is thought that Murray Cod and Golden Perch may be occasionally present in the lower reach of Sullivans Creek because of the movement of Lake Burley Griffin's stocked native fish into the creek.

### Sullivans Creek key actions

Actions for Sullivans Creek are to improve monitoring data. These actions are common to all ACT urban waters and are presented in section **11.8 Effectiveness of monitoring, evaluation and reporting processes for urban waters**.

## 7.4.2 Known pressures on the aquatic health of Sullivans Creek

This section discusses pressures that are specific to Sullivans Creek. For general water quality and aquatic health pressures see section **5.1 Impacts on Canberra's urban lakes and waterways and 5.2 Monitoring water quality and pollutants**.

Similar to Tuggeranong Creek, the historic legacy of channel modifications which have replaced much of the natural channel with artificially lowered concrete lined open drains is a significant pressure on the health of Sullivans Creek. These artificial channels provide no physical or biological value for the improvement of water quality and facilitate the increased concentrations and transport of pollution from urban runoff and other pollutant sources.

The continuing urban development in the Sullivans Creek catchment is impacting on aquatic health by increasing water pollutant contributions to the creek, including during construction. Of particular concern are increased turbidity, sediment and nutrients. The pressures of urban development on the aquatic health are discussed in more detail in **Chapter 12: Urban development and the ACT's lakes and waterways**.

## 7.4.3 Data trends for Sullivans Creek

Sullivans Creek can be divided into three reaches with markedly different features: the upper reach that flows through reserve and farmland from the headwaters to Flemington Road to the north of Lyneham; the middle reach that comprises a concrete drain that flows through the highly urbanised area of the inner north suburbs to the Australian National University (ANU); and the lower reach that flows through the ANU to Lake Burley Griffin.

While some water quality monitoring is undertaken in the upper and middle reaches of the creek, data are either from wetlands rather than the creek itself or too limited to be confidently used to identify condition and trends. Consequently, the data are not suitable for the evaluation required for this Investigation, meaning that the assessment is limited to the lower reach. However, since the data for the lower reach of the creek are not a true representation of the main creek system, conclusions cannot be drawn on the overall state of Sullivans Creek. The data does, however, show the quality of water entering Lake Burley Griffin.

Data for the lower reach of Sullivans Creek come from three sites within the ANU campus – Toad Hall Pond, Fellows Oval and the ANU boat ramp.

## Sullivans Creek catchment and hydrology

**Catchment**

Sullivans Creek commences in Goorooyaroo Nature Researve near Old Joe Hill and flows through the rapidly developing suburbs of Throsby and Harrison and the grasslands of Kenny. From there, the creek flows through the older suburbs of Canberra's inner north and the ANU campus before flowing into Lake Burley Griffin.

The Sullivans Creek catchment covers an area of 52.4 $km^2$ and has a north–south length of 12 km (Figure 7.36). It comprises a mix of conservation/recreation (47 per cent), urban (43 per cent), and rural (10 per cent) land uses. The catchment in the middle and lower reaches of Sullivans Creek is dominated by urban land (Figure 7.37).

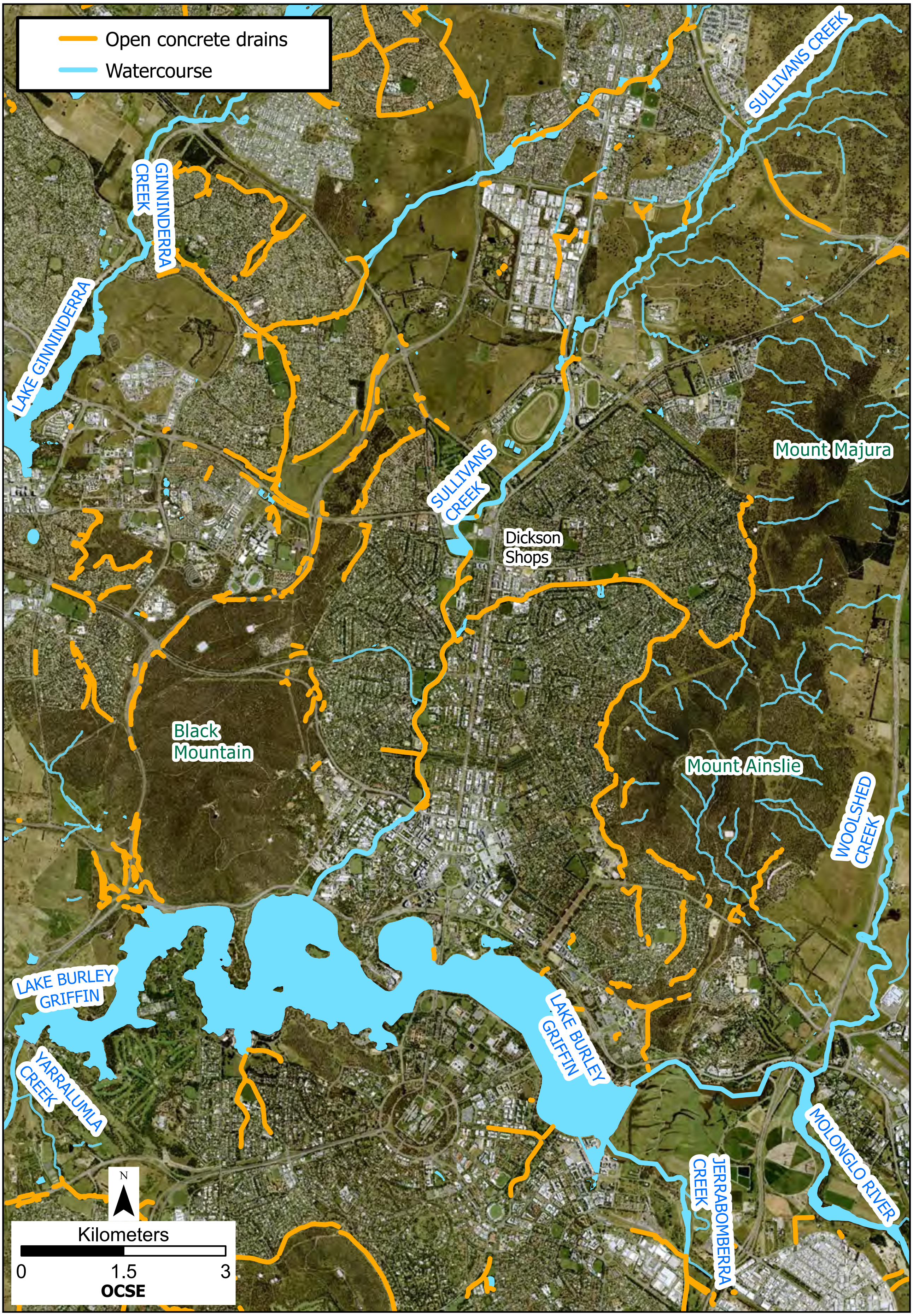



**Figure 7.36.** Overview of Sullivans Creek catchment.

**Data sourced from:** ACT Government.

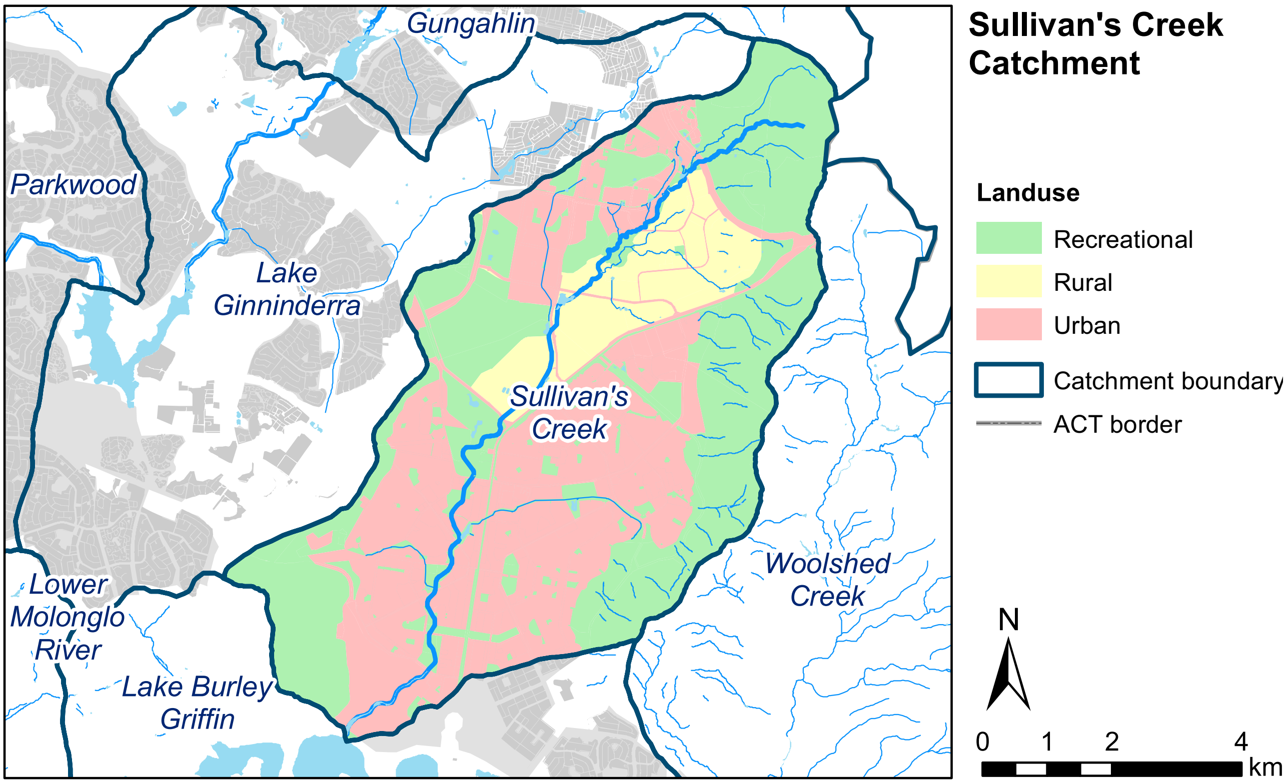



**Figure 7.37.** Sullivans Creek catchment and land uses.

**Source:** University of Canberra, Centre for Applied Water Science. Data from ACT Government.

### Flows

A series of urban drains contribute flow to Sullivans Creek, the largest of these flows from the foothills of Mt Ainslie and collects runoff from the suburbs of Ainslie, Hackett and Dickson. None of the tributaries is gauged which means it is not possible to determine the relative contributions to the main creek. The average annual flow in Sullivans Creek is between 2,000 megalitres at Lyneham (Southwell Park) and slightly more than 5,000 megalitres at ANU (Barry Drive). This makes it the smallest (by flow) of the four urban creek systems evaluated for this Investigation.

There has been a slight increase in the annual flow volumes in Sullivans Creek from 2010 onwards, this is despite the stormwater harvesting program in the catchment. This may be a result of increased runoff caused by the urban development in the upper catchment.

In dry periods, Sullivans Creek can contribute nearly one-fifth of the total inflows into Lake Burley Griffin (see section **6.1 Lake Burley Griffin**).

## 7.4.4 Water quality for Sullivans Creek

As with other urban creek systems, the negative impacts of human activities are often present in Sullivans Creek, with high concentrations of suspended sediment and rubbish evident within and along the creek. Such pollutants are typically deposited in the upstream sections of the ponds that have been built along the creek and degrade the recreational and aesthetic values.

Sullivans Creek and its urban tributaries have been retrofitted with ponds which are designed to manage the quality of water in the creek. These ponds have resulted in improved water quality, particularly under low flows, with reductions in nutrients observed across the ponds (see **Chapter 8 Canberra's urban ponds and wetlands**). While the water quality in the creek remains poor, without these interventions it is likely to be considerably worse.

It should be noted that poor water quality in Sullivans Creek contributes to water quality issues in Lake Burley Griffin affecting the recreational and aesthetic values of the lake, as well as its aquatic health.

### Phosphorus

Concentrations of total phosphorus in the lower reaches of Sullivans Creek were consistently outside the acceptable range with some very high concentrations recorded. From 2014 to July 2021, annual compliance with guidelines ranged from only 12 per cent to a maximum of 75 per cent of samples taken (Figure 7.38). Typically, more than 50 per cent of annual samples were above the acceptable range. This is likely because of the greatly modified catchment and aquatic ecosystems in the creek.

The limited data available for the middle reach of the creek suggests that high concentrations of phosphorus are also an issue for the highly urbanised and concrete lined areas of the creek. This finding is supported by research which found that concentrations of phosphorus are regularly well above the acceptable range in the creek.[174]

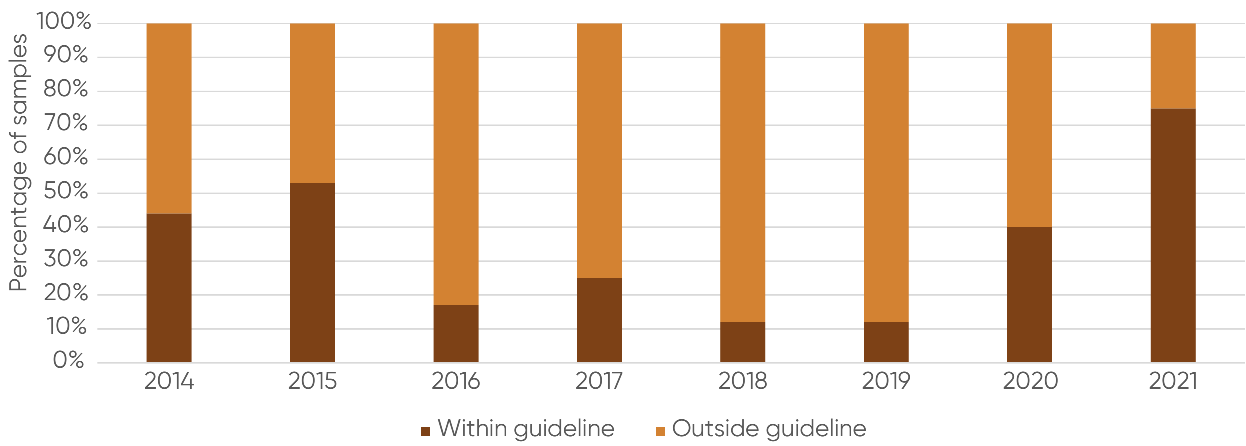



**Figure 7.38**. Annual average of the percentage of total phosphorus samples within guideline levels in the lower reaches of Sullivans Creek, 2014 to July 2021.

**Data sourced from:** Waterwatch.

174. Ubrihien, R., et al., 2019. *Urban Ponds Research Project Final Report. A report to the ACT Government by the Institute for Applied Ecology*. University of Canberra, Canberra.

## Nitrogen

Concentrations of nitrogen (as nitrate) in the lower reaches of Sullivans Creek were consistently outside the acceptable range with some high concentrations recorded. However, compliance was higher than for phosphorus. From 2015 to July 2021, annual compliance with guidelines ranged from only 25 per cent to a maximum of 88 per cent of samples taken, with all but one year having more than 55 per cent of samples within guideline levels (Figure 7.39). The high nitrogen concentrations are likely because of the greatly modified catchment and aquatic ecosystems in the creek.

The limited data available for the middle reach of the creek suggests that high concentrations of nitrogen are also an issue for the highly urbanised and concrete lined areas of the creek. This finding is supported by research which found that concentrations of nitrogen are regularly well above the acceptable range in the creek.[175]

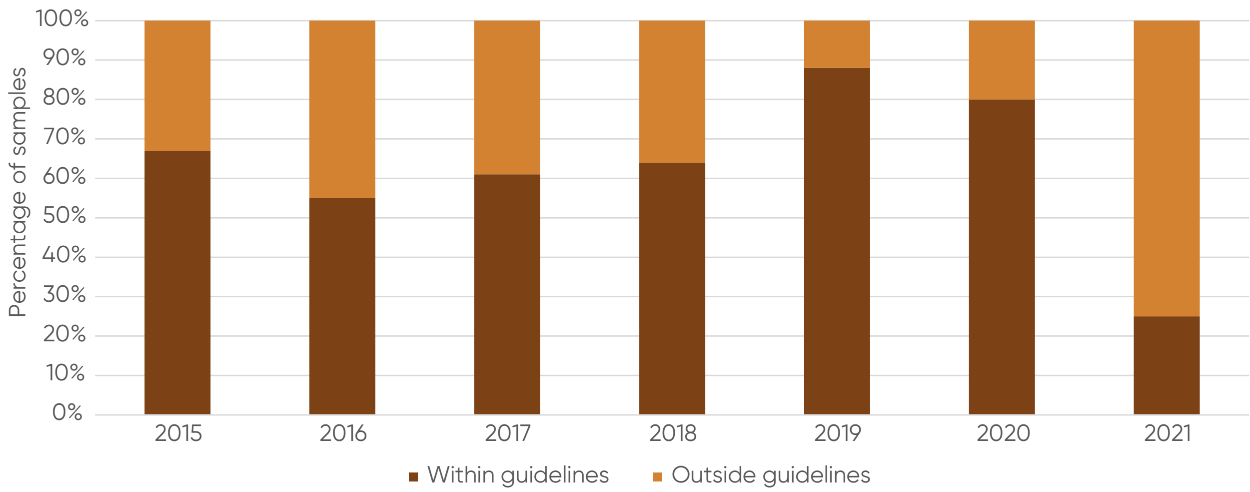



**Figure 7.39.** Annual average of the percentage of nitrate samples within guideline levels in the lower reaches of Sullivans Creek, 2015 to July 2021.
**Data sourced from:** Waterwatch.

## Turbidity

Turbidity levels in the lower reaches of Sullivans Creek were consistently outside the acceptable range. From 2011 to July 2021, annual compliance with guidelines ranged from just 17 per cent to a maximum of 66 per cent of samples taken, with eight years having around 50 per cent or more of samples above guideline levels (Figure 7.40). The highest turbidity levels appear to be associated with periods of high flow in the creek, however there is not a strong relationship between flow and turbidity. High turbidity is most likely caused by sediment transported by rainfall runoff from urban areas and developments. Another driver of high turbidity is the amount of fine organic content in the creek from the large loads of organic matter from urban areas.

175. Ibid

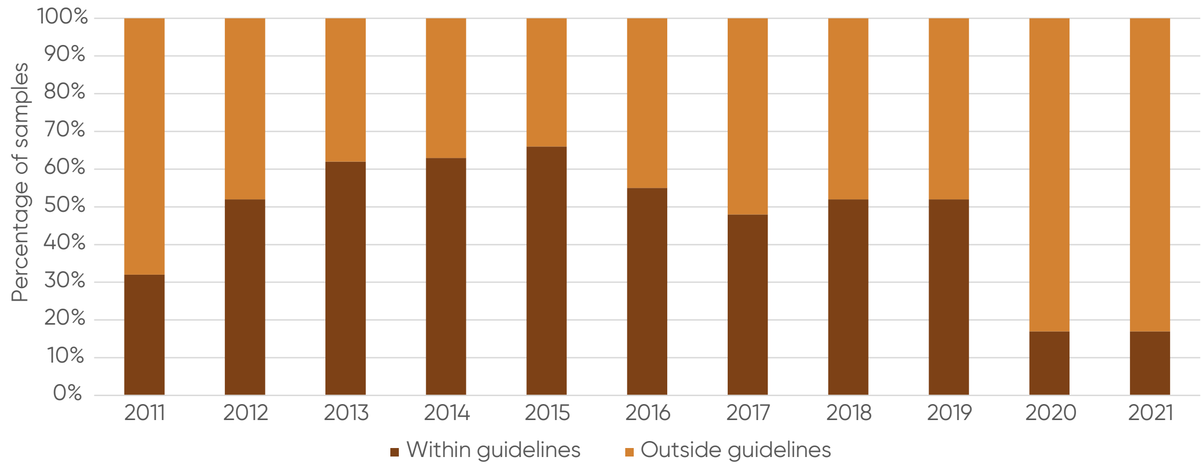



**Figure 7.40.** Annual average of the percentage of turbidity samples within guideline levels in the lower reaches of Sullivans Creek, 2011 to July 2021.

**Data sourced from:** Waterwatch.

## pH

From 2011 to July 2021, pH recordings in Sullivans Creek were always within the acceptable range.

## Dissolved oxygen

Concentrations of dissolved oxygen in the lower reaches of Sullivans Creek were consistently outside the acceptable range with some very low concentrations recorded. From 2014 to July 2021, annual compliance with guidelines ranged from 0 per cent in 2015 to a maximum of 57 per cent (Figure 7.41).

Low concentrations of dissolved oxygen in Sullivans Creek may, in part, be caused by a high organic load in the creek — possibly from the leaf fall of deciduous trees that line the creek in sections. High organic loads increase the biological oxygen demand and reduce the dissolved oxygen concentrations in the creek waters. Concentrations of dissolved oxygen are also influenced by a range of factors including water temperature and the time of day sampling occurs. This can make it difficult to interpret results.

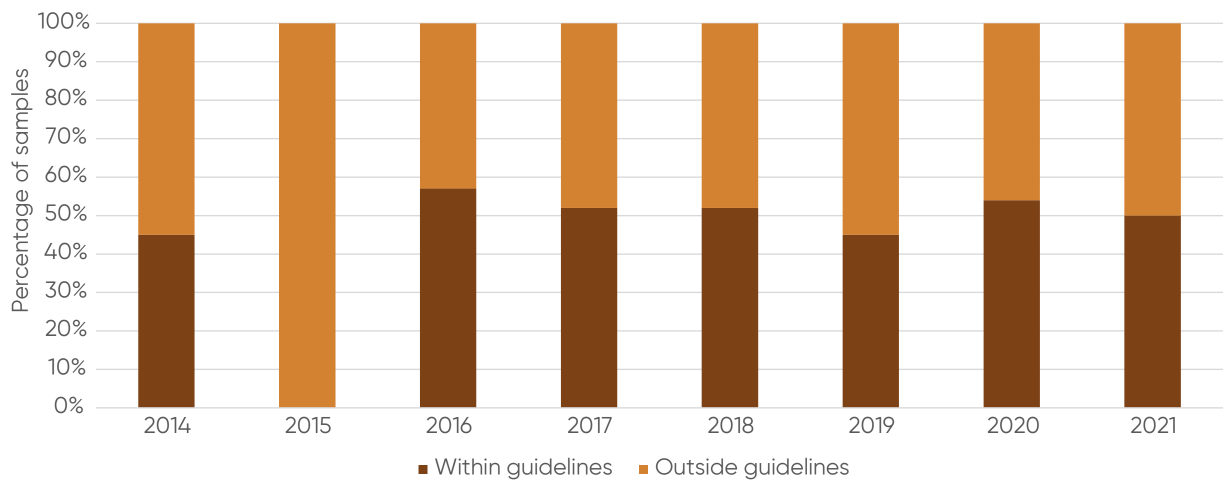



**Figure 7.41.** Annual average of the percentage of dissolved oxygen samples within guideline levels in the lower reaches of Sullivans Creek, 2014 to July 2021.

**Data sourced from:** Waterwatch.

## Conductivity

From 2011 to July 2021, electrical conductivity samples (a measure of salt concentration) in Sullivans Creek were sometimes outside the acceptable range. However, annual conductivity samples did meet guideline levels for around 70 per cent or more of the time in all but two of the years reported (Figure 7.42). It should also be noted that elevated levels of conductivity are consistent with water in concrete lined drains which make up a significant length of the creek's channel upstream of the sites sampled. Conductivity recordings within Sullivans Creek are consistent with those recorded in the other urban creeks and assessed in the Investigation.

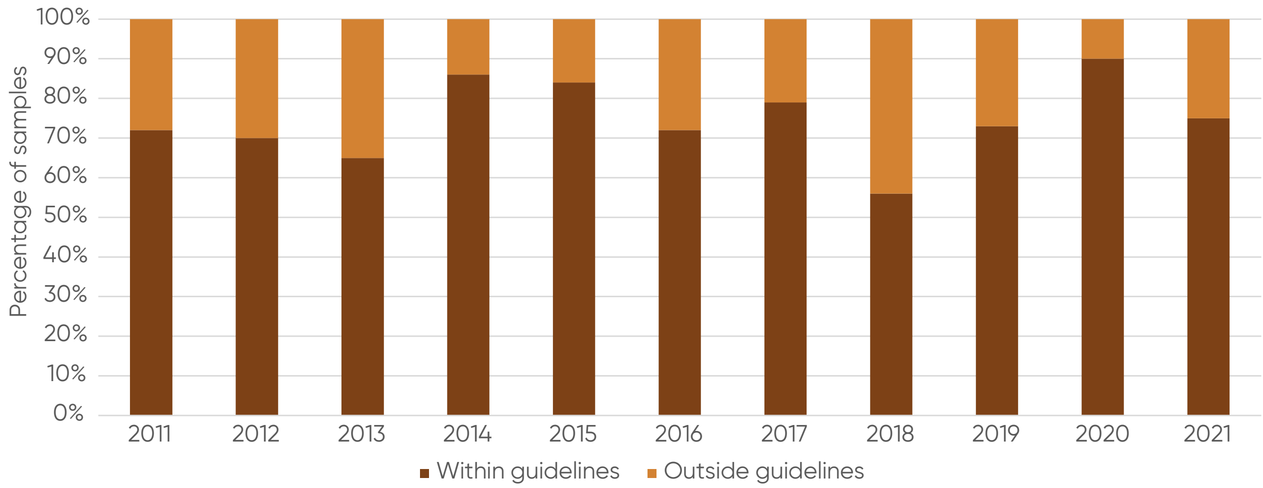



**Figure 7.42.** Annual average of the percentage of electrical conductivity samples within guideline levels in the lower reaches of Sullivans Creek, 2011 to July 2021.

**Data sourced from:** Waterwatch.

## Biodiversity and ecosystem health

Macroinvertebrate and riparian assessments provide the only measures of biodiversity and ecosystem health for Sullivans Creek. There are no data on native fish or other aquatic and riparian species. The concrete lined channels of Sullivans Creek and its major tributaries are almost entirely devoid of value for biodiversity and ecosystem health. However, the urban wetlands and ponds constructed in the Sullivans Creek catchment have attracted frogs, macroinvertebrates and bird species, with biodiversity growing as pond and wetland vegetation has matured. In addition, there are also regular sightings of Rakali in the lower reach of Sullivans Creek.

## Macroinvertebrate communities

Waterwatch macroinvertebrate surveys undertaken in the lower Sullivans Creek reach from 2014 to 2021 found the condition of the macroinvertebrate communities to be fair to good. Currently, there are insufficient data available for further upstream sites to be able to assess the overall condition of macroinvertebrate communities for the upper and middle reaches of Sullivans Creek.

## Riparian condition

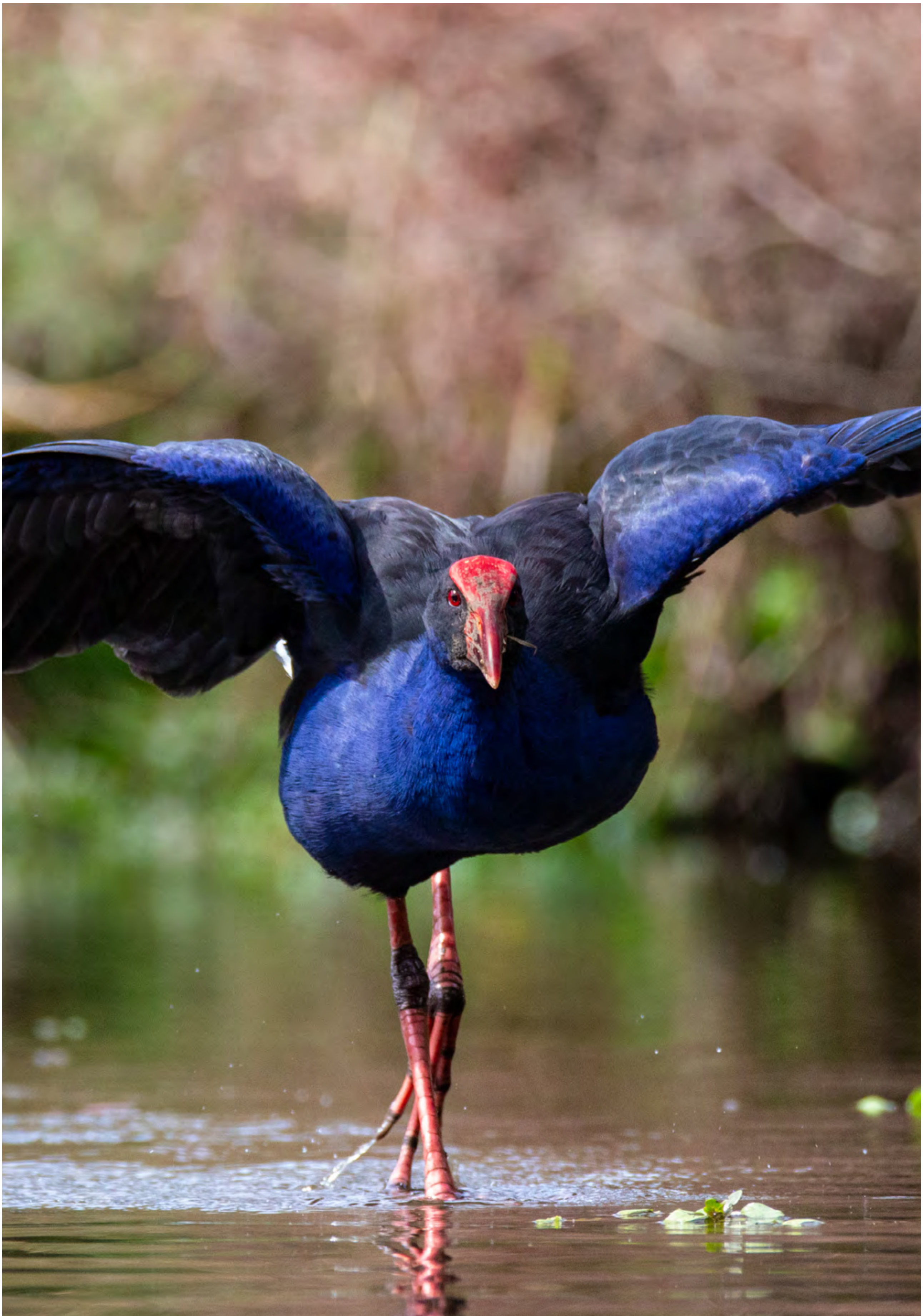
The riparian areas of the middle and lower reaches of Sullivans Creek are highly managed, typically comprising grasses, reeds and a scattered mixture of native and exotic trees. Most of the remnant native vegetation was removed by land clearing for agriculture and in the process of converting the creek to concrete channels.

The Waterwatch assessments of riparian condition identifies the riparian zone as fair to poor. In urban settings the Waterwatch methodology for riparian assessment may not be the most appropriate evaluation of condition. However, without specific guidance about the expected or targeted ecological condition, and accompanying monitoring data, the Waterwatch assessments remain the only available information.

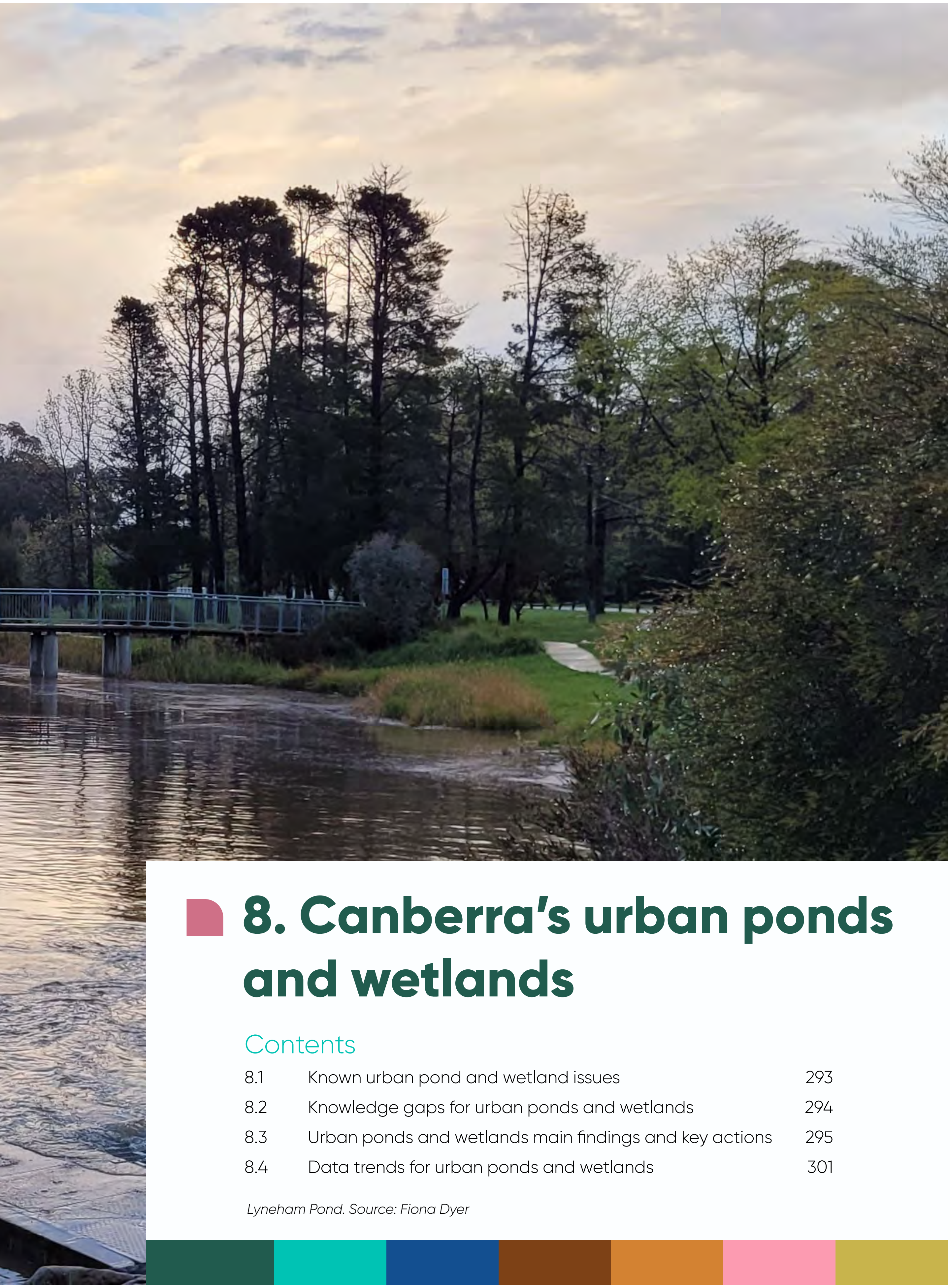
## Fish

Knowledge is limited for fish populations in Sullivans Creek with no regular survey work undertaken. Waterwatch surveys have noted the regular occurrence of high numbers of invasive fish species including carp and Eastern Gambusia. These species have negative effects on water quality and other fish species. The surveys also note that the native Western Carp Gudgeon are also common.

It is thought that Murray Cod and Golden Perch may be occasionally present in the lower reach of Sullivans Creek, because of the movement of Lake Burley Griffin's stocked native fish into the creek. Given the water quality issues evident in the Sullivans Creek, it is unlikely that native fish presence occurs for long periods.



*Purple Swamphen. Source: Ryan Colley*



# 8. Canberra's urban ponds and wetlands

## Contents



*Lyneham Pond. Source: Fiona Dyer*

## 8.1 Known urban pond and wetland issues

Although there is a lack of long term data to determine the performance of urban ponds and wetlands (see section **8.2 Knowledge gaps for urban ponds and wetlands**), there have been some reviews and research on Canberra's water sensitive urban design infrastructure.[179,180,181] These have found the following urban pond and wetland issues.

- Highly variable water quality reflecting climatic conditions.
- The common occurrence of odours, algal blooms and weed outbreaks.
- Poor in-pond/wetland water quality including low dissolved oxygen, high nutrient and high chlorophyll-a concentrations are common.
- High loads of organic matter (including leaf litter and grass clippings) causing low dissolved oxygen levels.
- High sediment loads particularly from the construction stage of developments because of poor erosion and sediment controls.
- The possibility that very high concentrations of nutrients in ponds and wetlands indicate some misuse of the stormwater system such as deliberate or accidental release of pollutants.
- Ponds and wetlands are generally less effective at removing phosphorus than they are at removing nitrogen and suspended sediment.
- Long periods of reduced water levels in ponds and wetlands can increase the risk of soil and wetland acidification, loss of habitat, fish mortality, greater access to islands by feral pests and changes to macrophytes. However, fluctuating water levels may have a positive impact on the function and value of the ponds by promoting the breakdown of organic materials.

The reviews of Canberra's urban ponds and wetlands also identified many management issues (see **Chapter 11 Effectiveness of ACT Government urban water management**).

Because of experiencing similar issues to those listed above, many jurisdictions in Australia have moved away from large ponds as stormwater treatment systems.[182] Despite this, the ACT Government has continued to construct large ponds in new development areas even though many of the existing ponds, particularly the older ones, are suffering from long-term water quality issues. However, it should be noted that although many of the ACT's ponds are known to have in-pond water quality issues, it is apparent that these urban water systems do provide benefits for the protection of downstream waters (see section **8.4 Data trends for urban ponds and wetlands**). Given that this is perhaps the main objective of the ACT's urban ponds and wetlands, their contribution to urban water management is positive.

179. Alluvium, 2016. *A Strategic Review and Analysis of Act Urban Water Quality Management Infrastructure. Final report by Alluvium Consulting Australia for the ACT Government, Environment and Planning Directorate, Basin Priority Project*. Canberra.
180. Ubrihien, R., et al., 2019. *Urban Ponds Research Project Final Report. A report to the ACT Government by the Institute for Applied Ecology.* University of Canberra, Canberra.
181. Abbott, S., et al., 2008. *Canberra's Urban Ponds – Ecological responses to variation in water level*. A report to the ACT Government by the Institute for Applied Ecology. Canberra.
182. Alluvium, 2016. *A Strategic Review and Analysis of Act Urban Water Quality Management Infrastructure. Final report by Alluvium Consulting Australia for the ACT Government, Environment and Planning Directorate, Basin Priority Project*. Canberra.

## 8.2 Knowledge gaps for urban ponds and wetlands

Although the ACT has invested significantly in lakes, ponds and wetlands as key elements of the water quality infrastructure of urban developments (see Figure 8.1), there is little data collected to evaluate the effectiveness or long-term performance of these assets. Current water quality monitoring programs mostly focus on catchment and waterway health rather than measuring the performance of stormwater systems. This means that the capacity to learn from existing investment and improve over time is limited.

Without event-based stormwater quality monitoring data, it is impossible to fully assess the performance of stormwater quality treatment systems. Waterwatch data are useful but are constrained by relatively low sampling frequency (monthly sampling), which often misses the high flow events which result in the highest pollutant levels. Targeted studies need to be undertaken to monitor and understand the performance of Canberra's urban ponds and wetlands.

For information on improving water quality and ecosystem health information see section **11.8 Effectiveness of monitoring, evaluation and reporting processes for urban waters**.

*Dickson channel entrance to Lyneham Pond. Source: Fiona Dyer*

## 8.3 Urban ponds and wetlands main findings and key actions

### Condition assessment against management and community values

The values used to assess the state of urban ponds and wetlands are based on selected key requirements for the quality of water as outlined in the *Canberra Urban Lakes and Ponds Land Management Plan*.[183] This includes assessing whether the water quality and aquatic health of ponds and wetlands support recreational, aesthetic and ecological values, and whether downstream water quality is maintained.[184]

This assessment of the ACT's urban ponds and wetlands incorporates data from 15 sites with 26 sampling locations. The findings presented are the average results for all sites combined. This means that some individual sites may have lower or higher compliance with water pollutant levels than the averages reported here. The assessments are informed by the findings discussed in section **8.4 Data Trends for urban ponds and wetlands**.

183. Environment, Planning and Sustainable Development Directorate, 2022. *Canberra Urban Lakes and Ponds Land Management Plan*. ACT Government, Canberra.
184. For urban ponds and wetlands, recreation values only relate to activities on lands immediately surrounding the waterbody, they do not include primary contact activities such as swimming. The Gungahlin, Yerrabi, Point Hut and North Weston Ponds also provide for recreational boating. Recreational fishing is also allowable in many of Canberra's urban ponds.

| Value | Status | Condition | Trend | Data quality |
|---|---|---|---|---|
| **UP&W1:** Is the water quality of urban ponds and wetlands sufficient to support the recreational and aesthetic functions? | Whilst urban ponds and wetlands generally support the expected recreational and aesthetic values, periods of high turbidity, sedimentation, large volumes of rubbish, clogged gross pollutant traps, cyanobacterial blooms and odours can degrade recreational and aesthetic values. Increased maintenance, such as rubbish and sediment removal, would greatly increase values. | Fair | - | High |
| **UP&W2:** Does the aquatic health of urban ponds and wetlands support ecological values? | Despite periods of poor water quality, the assessed ponds and wetlands are generally providing acceptable conditions for the maintenance of ecological values. This includes the maintenance of fish populations with only five fish kills reported in ponds and wetlands from 2011 to 2021, and only two of these impacting native fish. Riparian vegetation remains a concern with condition reported as poor for 67 per cent of surveys and another 5 per cent found to be degraded. The macrophyte condition in many urban ponds and wetlands has been regarded as being very poor. | Fair | - | Moderate |
| **UP&W3:** Do urban ponds and wetlands maintain downstream water quality? | Collectively, urban ponds and wetlands are improving and maintaining downstream water quality for some pollutants including nutrients and suspended sediment. However, performance varies with time and between ponds and wetlands. Improved management and macrophyte condition would increase the water quality performance of ponds and wetlands. Confidence in this assessment is low because of the lack of comprehensive data for pond and wetland performance during high flows. | Good | - | Moderate |

## Indicator assessment legend

### Condition

Good = Environmental condition is healthy OR pressure likely to have negligible impact on environmental condition/human health/waterbody values.

Fair = Environmental condition is neither positive or negative OR pressure likely to have limited impact on environmental condition/human health/ waterbody values.

Poor = Environmental condition is under significant stress, OR pressure likely to have significant impact on environmental condition/human health/ waterbody values.

Unknown = Data is insufficient to make an assessment of status and trends.

### Trend

↑ Improving
↓ Deteriorating
- Stable
? Unclear

### Data quality

High = Adequate high-quality evidence and high level of consensus

Moderate = Limited evidence or limited consensus

Low = Evidence and consensus too low to make an assessment

## Main findings for urban ponds and wetlands

This assessment of the ACT's urban ponds and wetlands incorporates data from 15 sites with 26 sampling locations. The findings presented are the average results for all sites combined. This means that some individual sites may have lower or higher compliance with water pollutant levels than the averages reported here.

### Water quality 2011 to July 2021

- The average compliance with water quality guidelines was more than 75 per cent of the time for all parameters measured. This suggests that the assessed ponds and wetlands are generally providing acceptable water quality for the maintenance of environmental, recreational and aesthetic values.
- There was considerable temporal and spatial variability in the pollutant levels with periods of poor water quality that degraded values.
- No noticeable trends in pond and wetland water quality were evident with pollutant levels reflecting the variation in the inflowing waters.

### Nutrients

- Total phosphorus concentrations were within the acceptable range for more than 90 per cent of samples for all but two of the years reported. For these two years, concentrations were still within the acceptable range for more than 80 per cent of the time.
- Nitrogen (as nitrate) concentrations were within the acceptable range more than 75 per cent of the time.[185]
- There were regular occurrences of very high concentrations of both phosphorus and nitrogen, which were likely to be indicative of contamination events rather than a persistent problem.

### Turbidity and suspended sediment

- The average compliance with turbidity guidelines was at least 85 per cent of the time, with seven years within guideline levels for more than 90 per cent of the time.
- Total suspended solids were within the acceptable range for at least 80 per cent of the time.
- Turbidity and suspended solid levels varied across sampling years and locations. For example, Dickson Wetland, Point Hut Pond and Yerrabi Pond were within the acceptable range for suspended solids for more than 90 per cent of the time, whereas the Lyneham Wetland was within the acceptable range for less than 60 per cent of the time.

### pH

- The average compliance with pH guidelines was more than 90 per cent of the time, with most years meeting the acceptable range for more than 95 per cent of the time.
- The Banksia Street Wetland had the lowest compliance, with pH levels within the acceptable range for 85 per cent of the time. It was the only site with lower than 90 per cent compliance.

185. The ACT Government has not established guideline values for nitrogen in the urban ponds and wetlands. This assessment is based on the lower of the nitrogen guideline values established for Lake Burley Griffin (less than 1 milligram per litre) in National Capital Authority, 2011, Lake Burley Griffin Water Quality Management Plan 2011. National Capital Authority, Canberra.

### Dissolved oxygen

- The average compliance with dissolved oxygen guidelines was more than 90 per cent for all but two of the years reported, which met the acceptable range for more than 85 per cent of the time.
- Lower dissolved oxygen concentrations were mainly found in the Lyneham and David Street Wetlands.

### Conductivity

- The average compliance with conductivity guidelines was more than 80 per cent of the time, with five of the years reported having more than 90 per cent compliance.
- The only assessed site to regularly experience elevated conductivity levels was the Valley Ponds (Gungahlin) where conductivity exceeded the acceptable range for 79 per cent of sampling occasions.

### Maintaining downstream water quality

- This Investigation has found that collectively, the urban ponds and wetlands are performing effectively as water quality control ponds for some pollutants, improving and maintaining downstream water quality.
- This shows that they are providing a valuable contribution to the ACT's stormwater management.
- Urban ponds and wetlands were found to reduce nutrient concentrations, with lower concentrations in the outflowing water compared to the inflowing water, although the nutrient removal performance varied with time and between ponds and wetlands.
- Flemington Pond and Yerrabi Pond consistently removed a significant proportion of nutrients whereas Dickson Wetland and David Street Wetlands were less effective.
- Urban ponds and wetlands are generally better at removing nitrogen from the system than phosphorus. However, for some ponds and wetlands, such as Jarramlee Pond, the removal of phosphorus has been more effective than the removal of nitrogen.
- Research has established that some of Canberra's urban ponds have been effective at reducing suspended sediment loads in the urban stormwater system, particularly the Banksia Street Wetland and Coombs B Pond.

## Recreation and aesthetic values

- The negative impacts of human activities are evident in some ponds and wetlands which significantly degrades recreational and aesthetic values. This includes large amounts of rubbish in inlet zones and in shore areas.
- Clogged gross pollutant traps often detract from the aesthetic values.
- It is clear that the involvement of volunteers in maintaining ponds and wetlands is becoming increasingly important in the ACT. Although the ACT Government is responsible for clearing out gross pollutant traps, this does not appear to be done regularly enough in some areas to maintain aesthetic values. There can be a reliance on community volunteers to clean out gross pollutant traps.
- Some of the ACT's urban ponds and wetlands experience regular cyanobacterial blooms which negatively impacts on recreational and aesthetic values.
- There are frequent occasions when the water within the ACT's urban ponds and wetlands is turbid with a slight odour.

## Ecosystem health and biodiversity

- Fish in the ACT's urban ponds and wetlands are known to be dominated by self-sustaining populations of invasive species including European Carp, Eastern Gambusia, Oriental Weatherloach and Redfin Perch.
- The presence of some invasive species is from illegal stocking by community members. This is a significant issue in the ACT and is especially problematic when it occurs after invasive species have been removed from ponds to improve water quality and aquatic health.
- Native fish are only present in those ponds that are included in the ACT Government fish stocking program. This program has seen nearly 165,000 native fish stocked to selected urban ponds from 2011–12 to 2020–21. This includes the stocking of around 67,500 Murray Cod, and 97,400 Golden Perch.
- Smaller ponds that have undergone stocking include the Upper Stranger and Isabella Ponds to help restore the aquatic ecosystem and to control mosquito numbers.
- The larger and established ponds are more successful at supporting native fish populations, especially Golden Perch. The Yerrabi and Gungahlin Ponds have been stocked with Murray Cod and Golden Perch since 1999.
- As the ACT builds more ponds and wetlands for new urban development areas, consideration needs to be given to extending the stocking program.
- The water quality and ecosystem health of many of the ACT's ponds and wetlands are generally sufficient for the survival of fish. There were only five investigated fish kills in urban ponds and wetlands from 2011 to 2021, with only two impacting native fish. The most significant fish kill was recorded in September 2014 when more than 100 Murray Cod died in Yerrabi Pond. This was thought to have occurred because of low dissolved oxygen levels.

### Riparian condition

- For the 15 ponds and wetlands used in this Investigation, the average long-term data indicates that riparian condition is poor for 67 per cent of the time, fair for 27 per cent of the time, degraded for 5 per cent of the time, and very rarely classed as in good condition at only 1 per cent of the time.
- The Yerrabi, Isabella and Point Hut Ponds were all assessed as having riparian vegetation in degraded condition at least once during the survey years.
- David Street Wetland demonstrated the best riparian condition, classed as good or fair for more than 80 per cent of the time across all survey years.
- There are limited resources to actively manage weeds and undertake routine maintenance other than mowing for urban pond and wetland riparian zones.
- Ponds and wetlands where there are active community groups have far better maintained vegetation compared to other ponds and wetlands. Providing resources to support community groups to maintain these areas is likely to be of significant benefit.
- The macrophyte condition in many urban ponds and wetlands has also been regarded as being very poor. This limits the uptake nutrients and may indicate that periods of poor water quality are impacting on macrophyte health and growth.

### Urban ponds and wetlands key actions

That the ACT Government:

**Key Action 8.1:** Develop a comprehensive monitoring framework and reporting program to improve understanding of the ecological services provided by Canberra's urban ponds and wetlands. This should include assessments of water pollutant mitigation, and ecological and recreational values. Data obtained from the monitoring framework should be used to improve the performance of current and future water sensitive urban design measures.

**Key Action 8.2:** Extend the ACT Government fish stocking program to increase the number of ponds stocked, as well as the number and type of fish stocked. This includes building capacity to stock native fish to new ponds and wetlands planned for urban development areas.

**Key Action 8.3:** Provide resources to support community groups to maintain the health and aesthetic value of ponds and wetlands, including the removal of rubbish and the establishment and maintenance of vegetation.

Other actions for the urban ponds and wetlands are to improve monitoring data. These actions are common to all ACT urban waters and are presented in section **11.8 Effectiveness of monitoring, evaluation and reporting processes for urban waters**.

## 8.4 Data trends for urban ponds and wetlands

Of the 198 of constructed ponds and wetlands in the ACT (Figure 8.1), only 15 have sufficient data sets to be able to assess water quality and ecosystem health trends from 2011 to July 2021. This assessment of the ACT's urban ponds and wetlands incorporates data from these 15 sites with 26 sampling locations. The findings presented are the average results for all sites combined. This means that some individual sites may have lower or higher compliance with water pollutant levels than the averages reported here.

The data have been obtained from Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program. The sites analysed in this section are detailed in **Appendix 3**.

*Spotted Marsh Frog. Source: Ryan Colley*

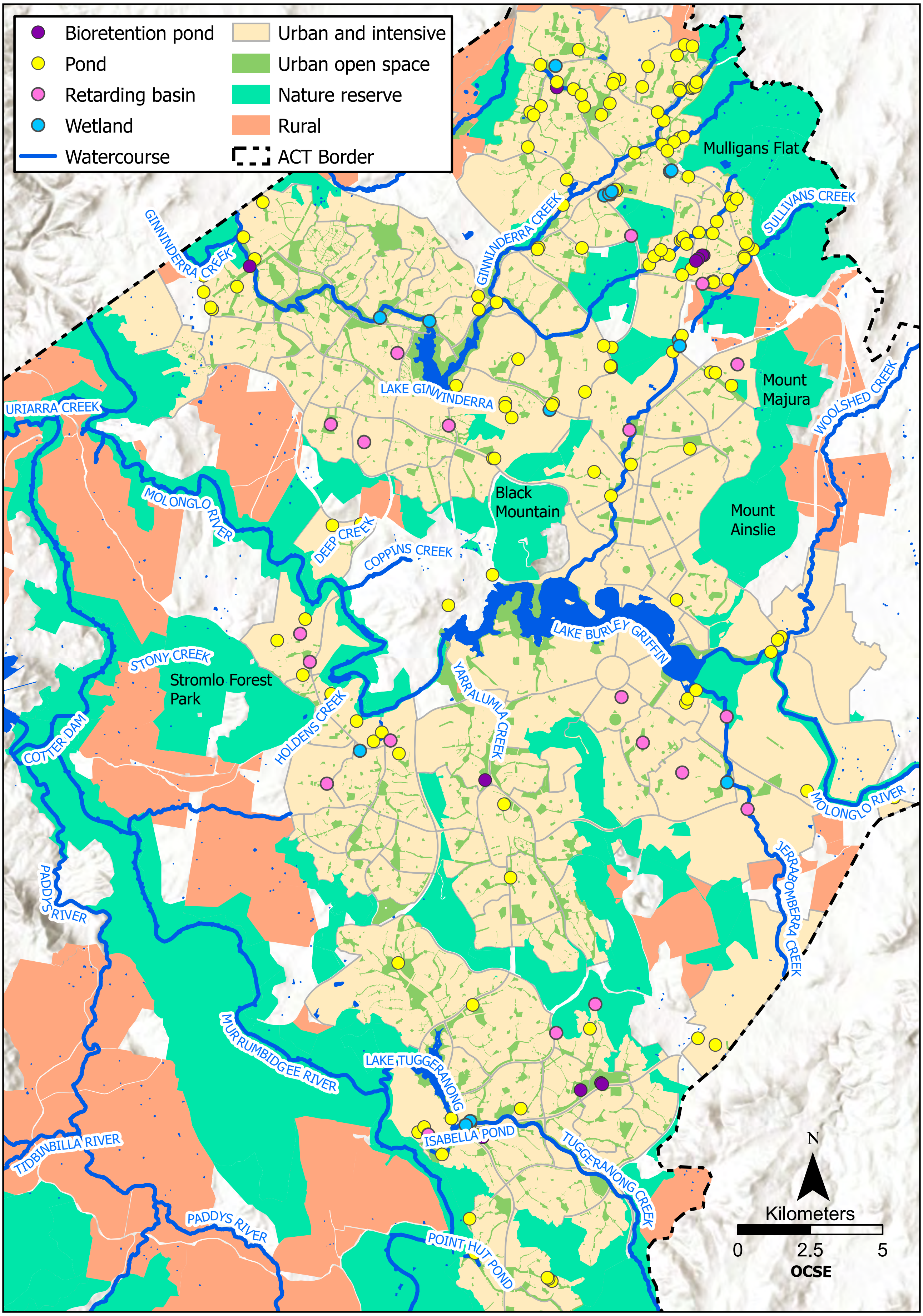



**Figure 8.1.** Main urban ponds and wetlands in the ACT's urban areas.

**Data sourced from:** University of Canberra Centre for Applied Water Science and ACT Government, background data from ESRI..

## Water quality 2011 to July 2021

For the 15 assessed urban ponds and wetlands, the average compliance with water quality guidelines was more than 75 per cent of the time for all parameters measured. This suggests that the assessed ponds and wetlands are generally providing acceptable water quality for the maintenance of environmental, recreational and aesthetic values. However, there was considerable temporal and spatial variability in the pollutant levels with periods of poor water quality that degraded values. No noticeable trends in pond and wetland water quality were evident with pollutant levels reflecting the variation in the inflowing waters.

Although these results may mean that, as a collective, Canberra's urban ponds and wetlands generally display good water quality, this cannot be established without more comprehensive data for other ponds and wetlands. This Investigation has found that there are substantial differences between ponds for both water quality and pollution control performance.

Results for specific water quality parameters are discussed below.

## Nutrients

For the assessed urban ponds and wetlands, the average compliance with total phosphorus guidelines was more than 90 per cent of the time for all but two of the years reported. For those two years, phosphorus concentrations were still within the acceptable range for more than 80 per cent of the time (Figure 8.2). Nitrogen (as nitrate) concentrations were within the acceptable range for more than 75 per cent of the time.[186]

There were regular occurrences of very high concentrations of both phosphorus and nitrogen, including some extreme concentrations (up to 1 milligram per litre of phosphorus and 10 milligrams per litre for nitrate), although these were sporadic in nature and may be more indicative of irregular contamination events rather than a persistent problem.

Such high concentrations found in monitoring programs should trigger a process to respond to them. For example, nitrate concentrations of 10 mg/L can adversely affect large numbers of species of freshwater invertebrates, fish and amphibians which would suggest that at least some of the concentrations recorded should be cause for concern. Research on six of Canberra's urban ponds also detected similar high concentration contamination events.[187]

186. The ACT Government has not established guideline values for nitrogen in the urban ponds and wetlands. This assessment is based on the lower of the nitrogen guideline values established for Lake Burley Griffin (less than 1 milligram per litre) in – National Capital Authority, 2011, *Lake Burley Griffin Water Quality Management Plan* 2011. National Capital Authority, Canberra.
187. Ubrihien, R., et al., 2019. *Urban Ponds Research Project Final Report. A report to the ACT Government by the Institute for Applied Ecology*. University of Canberra, Canberra.

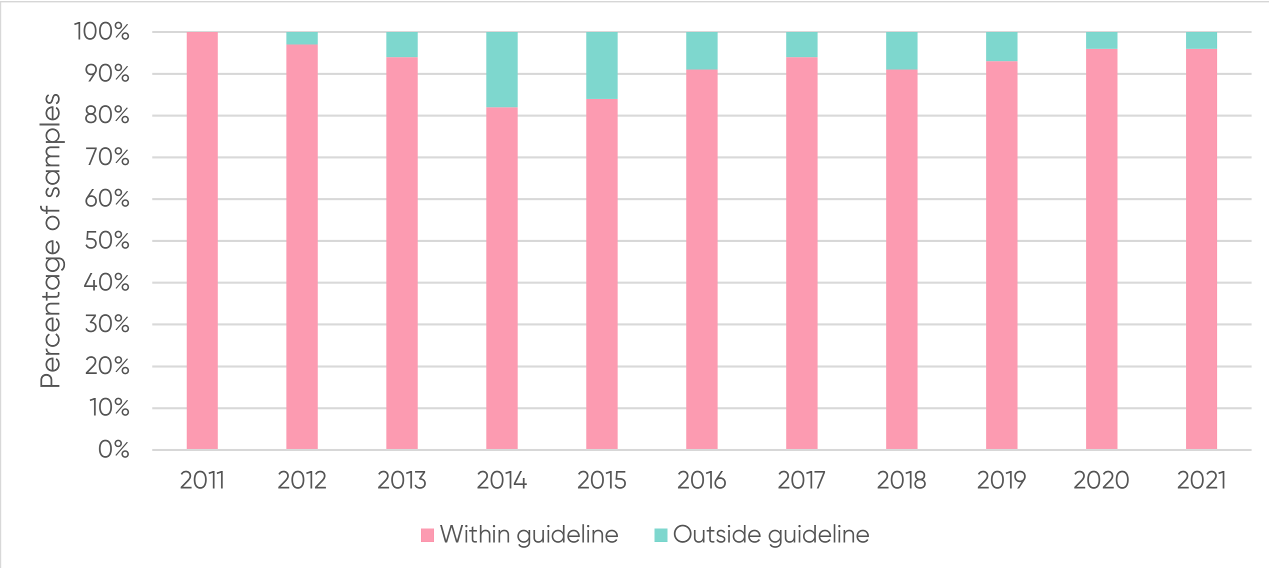



**Figure 8.2.** Annual average of the percentage of total phosphorus samples within guideline levels in 15 urban ponds and wetlands, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

## Turbidity and suspended sediment

For the assessed urban ponds and wetlands, the average compliance with turbidity guidelines was at least 85 per cent of the time, with seven years within guideline levels for more than 90 per cent of the time (Figure 8.3). Total suspended solids were within the acceptable range for at least 80 per cent of the time (Figure 8.4).

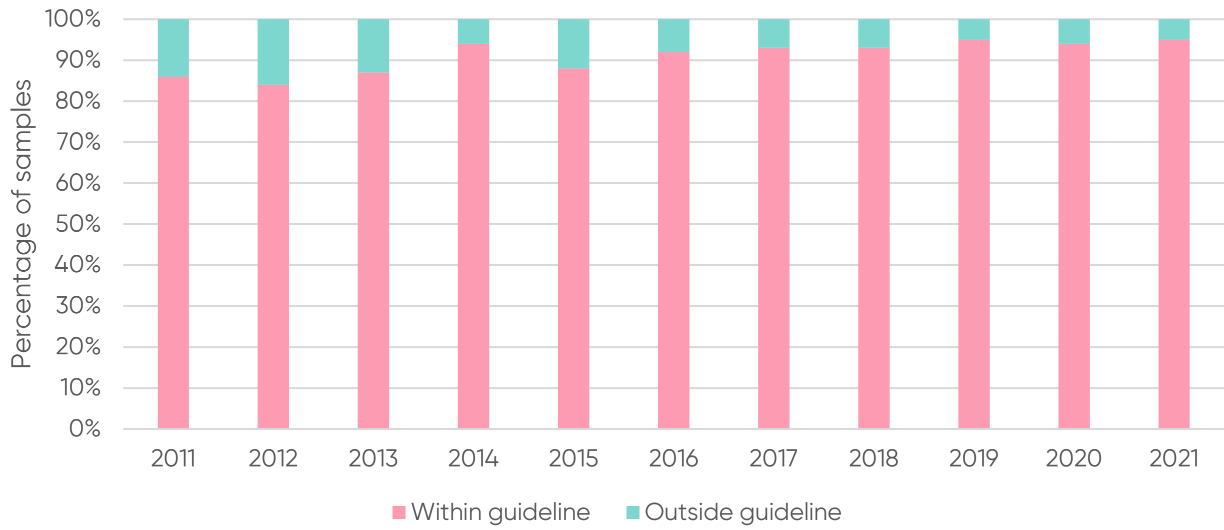



**Figure 8.3.** Annual average of the percentage of turbidity samples within guideline levels in 15 urban ponds and wetlands, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

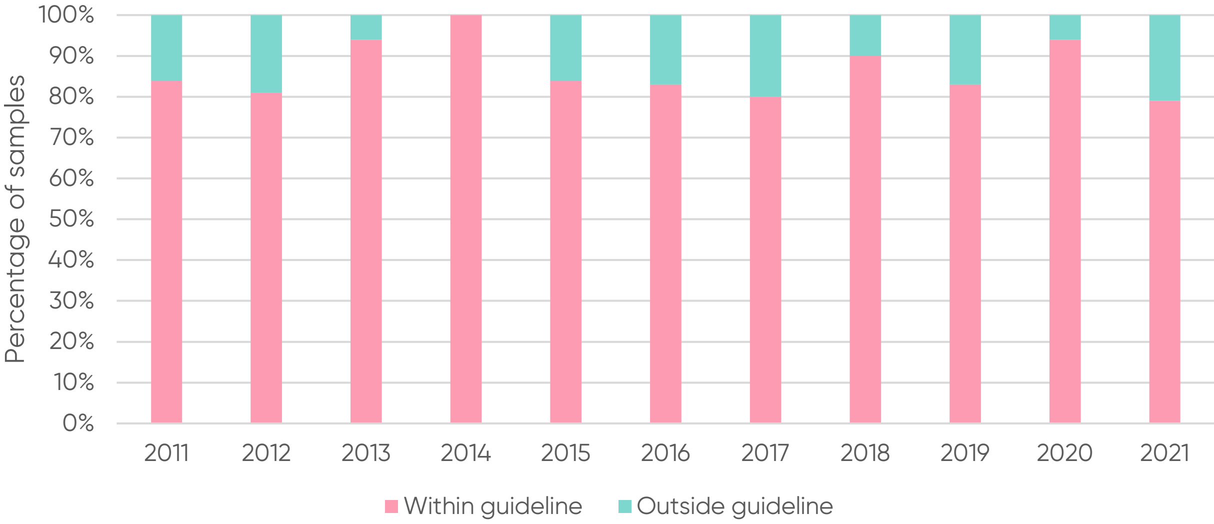



**Figure 8.4.** Annual average of the percentage of total suspended solid samples within guideline levels in 15 urban ponds and wetlands, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

Turbidity and suspended solid levels varied across sampling years and locations. For example, Gungahlin Pond was the only individual site where turbidity was within guidelines for less than 80 per cent of the time. For suspended solids, Dickson Wetland, Point Hut Pond and Yerrabi Pond were consistently within the acceptable range more than 90 per cent of the time, whereas the Lyneham Wetland was only within the acceptable range for less than 60 per cent of the time.

Both Gungahlin Pond and Lyneham Wetland have recorded average total suspended solid concentrations above guideline levels on multiple occasions, with a notable increase at the Gungahlin Pond site during 2017 and 2021. Research on the ACT's urban ponds also highlighted high suspended solid concentrations at the Banksia Street, Coombs A, Coombs B and David Street Ponds.[188]

The cause of these elevated sediment concentrations may be a combination of local sediment runoff from urban development or rainfall events. The ACT Water Reports (2012–2014) recognised that suspended solids at Point Hut Pond over the 2012–13 period were often elevated, possibly reflecting building activity and gardening in the catchment.[189] It has been suggested that a driver of increased sediment loads within the Lyneham Wetland may have been the accumulation of sediment and organic material within the pond from an underperforming gross pollutant trap at the inlet of the wetland.[190]

188. Ubrihien, R., et al., 2019. *Urban Ponds Research Project Final Report. A report to the ACT Government by the Institute for Applied Ecology*. University of Canberra, Canberra.
189. Environment, Planning and Sustainable Development Directorate. *Water Reports.* ACT Government Canberra.
190. Alluvium, 2016. *A Strategic Review and Analysis of Act Urban Water Quality Management Infrastructure. Final report by Alluvium Consulting Australia for the ACT Government, Environment and Planning Directorate, Basin Priority Project*. Canberra.

## pH

For the 15 assessed urban ponds and wetlands, the average compliance with pH guidelines was more than 90 per cent of the time, with most years meeting the acceptable range for more than 95 per cent of the time. The Lower Stranger Pond was within the acceptable range of pH for 100 per cent of the time. The Banksia Street Wetland had the lowest compliance, with pH levels within the acceptable range for 85 per cent of the time, and was the only site below 90 per cent compliance. Consequently, all of the assessed ponds and wetlands are likely to provide the acceptable pH range required by aquatic species.

## Dissolved oxygen

For the assessed urban ponds and wetlands, the average compliance with dissolved oxygen guidelines was more than 90 per cent for all but two of the years reported, which met the acceptable range for more than 85 per cent of the time.

Lower dissolved oxygen concentrations were mainly found in the Lyneham and David Street Wetlands. Dissolved oxygen concentrations were found to be lowest in the bottom waters of the ponds and wetlands assessed but the concentrations recorded were consistent with ponds that stratify over summer.

## Conductivity

For the 15 assessed urban ponds and wetlands, the average compliance with conductivity guidelines was more than 80 per cent of the time, with five of the years having more than 90 per cent compliance (Figure 8.5). The only assessed site to regularly experience elevated conductivity levels was the Valley Ponds (Gungahlin) where conductivity exceeded the acceptable range for 79 per cent of sampling occasions.

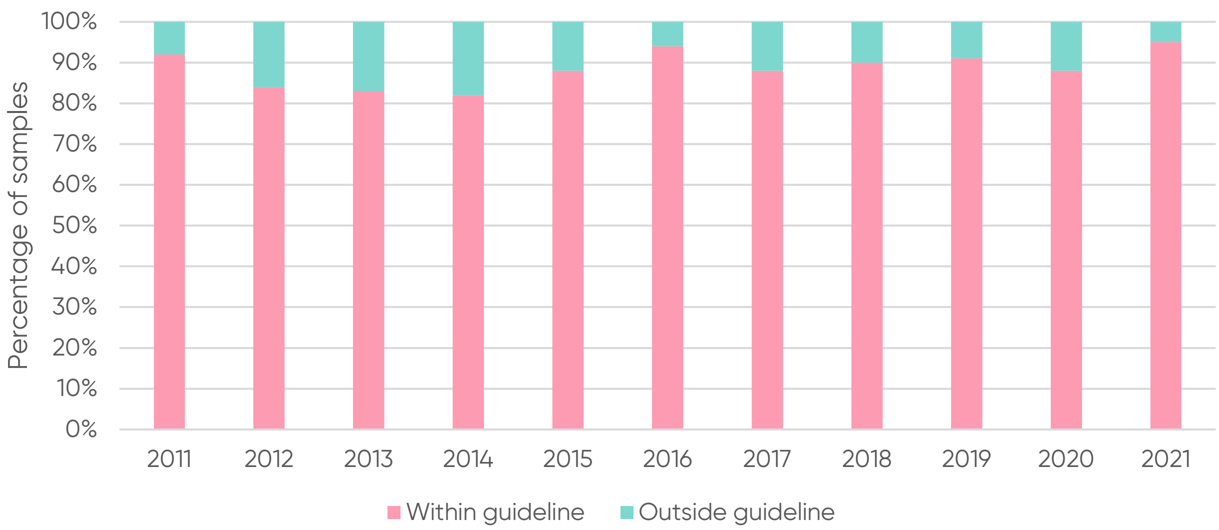



**Figure 8.5**. Annual average of the percentage of conductivity samples within guideline levels in 15 urban ponds and wetlands, 2011 to July 2021.

**Data sourced from:** Waterwatch and the ACT Government Lakes and Rivers Water Quality Monitoring Program.

## Maintaining downstream water quality

The long-term data available for the assessed sites suggests that collectively the urban ponds and wetlands are performing effectively as water quality control ponds for some pollutants. This means that they are successfully improving and maintaining downstream water quality, providing a valuable contribution to the ACT's stormwater management.

Urban ponds and wetlands were found to consistently reduce nutrient concentrations, with lower concentrations in the outflowing water compared to the inflowing water, although the nutrient removal performance varied with time and between ponds and wetlands. For example, Flemington Pond and Yerrabi Pond consistently removed a significant proportion of the nutrients whereas Dickson Wetland and David Street Wetlands were less effective.

The nutrient findings in this Investigation are supported by more detailed research that used weekly water quality sampling to assess the performance of Canberra's urban ponds.[191] This research found that the concentrations of nutrients moving through ACT urban waterways were reduced by urban ponds, regardless of the catchment and time of construction.

Results for this Investigation also suggests that ponds and wetlands are generally better at removing nitrogen from the system, rather than phosphorus. However, the data also shows that for some ponds and wetlands, such as Jarramlee Pond, the removal of phosphorus has been more effective than the removal of nitrogen. This finding is contrary to a previous study which found that urban ponds were less effective at removing phosphorus than they are at removing nitrogen.[192]

Long term monitoring data for total suspended solids within the ACT's urban ponds and wetlands is currently only available for six sites – Dickson and Lyneham Wetlands, Gungahlin Pond, Point Hut Pond, Flemington Road Pond, and Yerrabi Pond. The data are collected from a single sampling point at each site, excluding any assessment of suspended sediment changes from the inflow to the outflow. However, it has been established that some of Canberra's urban ponds have been effective at reducing suspended sediment loads in the urban stormwater system, particularly the Banksia Street Wetland and Coombs B Pond, with sites downstream recording significantly lower suspended sediment concentrations than inflows.[193]

## Aesthetic condition

An important purpose of the ACT's urban ponds and wetlands is to provide a range of recreational and aesthetic values. Unfortunately, the negative impacts of human activities can be evident in some ponds and wetlands which significantly degrades these values. This includes large amounts of rubbish collecting in inlet zones and in shore areas. A lot of the rubbish comes from stormwater flows which collects rubbish and then flows through urban drains and into ponds and wetlands. Gross pollutant traps prevent the flow of much of the larger rubbish items but when filled with debris and litter, these traps detract from the aesthetic values.

191. Ubrihien, R., et al., 2019. *Urban Ponds Research Project Final Report. A report to the ACT Government by the Institute for Applied Ecology*. University of Canberra, Canberra.
192. Ibid.
193. Ibid.

It is clear that the involvement of volunteers in maintaining ponds and wetlands is becoming increasingly important in the ACT. Although the ACT Government is responsible for clearing out gross pollutant traps, this does not appear to be done regularly enough in some areas to maintain aesthetic values, possibly because of a lack of resources. There can be a reliance on community volunteers to clean out gross pollutant traps. For example, local volunteers at Dickson Wetland collect rubbish every year to improve the visual amenity.

Some of the ACT's urban ponds and wetlands experience regular cyanobacterial blooms which negatively impacts on recreational and aesthetic values. Such blooms are generally confined to summer periods, the very season that many community members visit ponds and wetlands. While an improvement to the inflowing water quality would be beneficial to the aesthetic and recreational amenity of the ACT's urban ponds and wetlands, it must be noted that one of their main purposes is to treat and manage inflows of poor water quality which increases the risk of algal blooms. This means that the expectations of these urban waterways to provide recreational and aesthetic values are not well aligned with their water pollution control roles.

Waterwatch monitoring data for a number of ponds and wetlands identifies frequent occasions that the water within the ACT's urban ponds and wetlands is turbid with a slight odour. However, there is little information about possible causes or the longevity of such issues. Turbid water is generally associated with inflows after storm events which transport suspended sediment. But coloured water can also occur through the accumulation and breakdown of organic material. Odours can often occur during dry conditions or drawdown of some ponds, with strong smells associated with decaying organic matter. Such odours rarely persist for more than a few weeks and stop when the water level of ponds and wetland rises after rainfall.

## Biodiversity and ecosystem health

### Fish

Fish in the ACT's urban ponds and wetlands are known to be dominated by self-sustaining populations of invasive species including European Carp, Eastern Gambusia, Oriental Weatherloach, and Redfin Perch. The presence of some of these species is from illegal stocking by community members which is a significant issue in the ACT. Illegal stocking is especially problematic when it occurs after invasive species have been removed from ponds to improve water quality and aquatic health.

Native fish are only present in those ponds that are included in the ACT Government fish stocking program.[194] This program has seen nearly 165,000 native fish stocked to selected urban ponds from 2011–12 to 2020–21. This includes the stocking of around 67,500 Murray Cod, and 97,400 Golden Perch. Stocking is undertaken to provide a recreational fishery that is easily accessible to Canberrans. Regular stocking is also required to maintain populations of native fish species because the ponds do not provide the appropriate conditions for breeding. This is mainly because of the lack of flowing water and suitable habitat required for successful breeding.

194. Environment and Planning Directorate, 2015. *Fish stocking plan for the Australian Capital Territory 2015-2020*. ACT Government, Canberra.

Under the ACT Government Fish Stocking Plan, smaller ponds designed for pollution control purposes, such as sediment retention, are generally not stocked with native fish, generally being unsuccessful because of competition from high numbers of invasive fish species and water quality issues. The water quality in smaller ponds fluctuates significantly in response to catchment conditions, for example, heavy rain events following dry periods can deplete dissolved oxygen levels, such changes are highly detrimental to fish populations. The stocking of smaller ponds is usually dependent on funds contributed by angling groups (such as the Canberra Fisherman's Club) and other management agencies. Smaller ponds that have undergone stocking include the Upper Stranger and Isabella Ponds which have been stocked with native fish since 2018 to help restore the aquatic ecosystem and to control mosquito numbers after the ponds were drained and European Carp removed. The West Belconnen and Point Hut Ponds have not been stocked since 2015–16 and the Coombs Ponds were stocked just once in 2017–18.

The larger and established ponds are more successful at supporting native fish populations, especially Golden Perch. The Yerrabi and Gungahlin Ponds have been stocked with Murray Cod and Golden Perch since 1999.

As the ACT builds more ponds and wetlands for new urban development areas, consideration needs to be given to extending the stocking program. This will require more resources as the current stocking program is already limited in the number of ponds stocked, as well as the number and type of fish able to be stocked.

Whilst the water quality and ecosystem health of many of the ACT's ponds and wetlands are generally sufficient for the survival of fish, there have been a small number of fish kills investigated (only 5 from 2011 to 2021), with only two impacting native fish. The most significant fish kill was recorded in September 2014 when more than 100 Murray Cod died in Yerrabi Pond. This was thought to have occurred because of low dissolved oxygen levels.

## Riparian condition

The vegetation around and within the ACT's urban ponds and wetlands has been planted and is maintained through regular mowing and management, consistent with the management of the urban park estate. There are limited resources to actively manage weeds and undertake routine maintenance other than mowing. There is a mix of native and exotic vegetation, the condition of which is defined by the level of management effort. Like all urban parklands, they are subject to the pressures of human activities that introduce rubbish and other pollutants, exotic and invasive plants, and the creation of informal pathways among the riparian vegetation that lead to increased erosion and plant loss. Ponds and wetlands where there are active community groups (such as Banksia Street Wetland) have far better maintained vegetation compared to other ponds and wetlands. Providing resources to support community groups to maintain these areas is likely to be of significant benefit (see **Chapter 10: Management and governance of urban lakes and waterways**).

The Rapid Appraisal of the Riparian Condition (RARC) score is used by Waterwatch to give an indication of the riparian condition. The appraisal occurs every two years, in the years 2015, 2017, 2019 and 2021. For the 15 ponds and wetlands used in this Investigation, the average long-term data indicates that riparian condition is poor for 67 per cent of the time, fair for 27 per cent of the time, degraded for 5 per cent of the time, and very rarely classed as in good condition at only 1 per cent of the time (Figure 8.6). No ponds or wetlands recorded excellent riparian condition and the Yerrabi, Isabella and Point Hut Ponds were all assessed as having riparian vegetation in degraded condition at least once during the survey years. David Street Wetland demonstrated the best riparian condition, classed as good or fair for more than 80 per cent of the time across all survey years. Riparian condition for the Dickson Wetland was also assessed as being in fair condition for more than 80 per cent of the time.

It should be noted that the approach used to establish the riparian vegetation condition was designed for the riparian areas of rivers and is not designed for a constructed urban system where the vegetation has been planted and is maintained by local community groups and park managers. Consequently, the riparian assessment methodology used by Waterwatch will likely give low scores and is perhaps not a suitable approach for the ACT's urban ponds and wetlands. In such highly managed environments, a set of clear expectations needs to be developed to better understand the condition of vegetation.

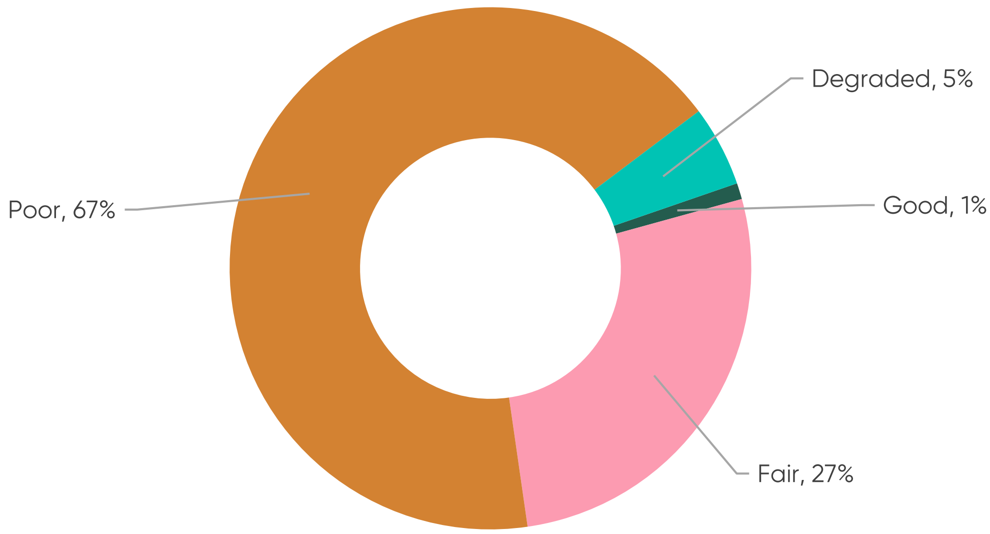



**Figure 8.6.** Percentage of riparian condition scores in good, fair, poor or degraded condition from 15 urban ponds and wetlands in the ACT, 2015 to 2021.
**Data sourced from:** Waterwatch data for Rapid Appraisal of Riparian Condition

The macrophyte condition in many urban ponds and wetlands has also been regarded as being very poor.[195] This suggests that the urban ponds and wetlands are possibly not performing to their full potential, with poor macrophyte condition limiting the uptake of nutrients. Degraded macrophyte condition may also indicate periods of poor water quality impacting on macrophyte health and growth.

195. Alluvium, 2016. *A Strategic Review and Analysis of Act Urban Water Quality Management Infrastructure. Final report by Alluvium Consulting Australia for the ACT Government, Environment and Planning Directorate, Basin Priority Project.* Canberra.

## Macrophytes in urban ponds and wetlands

Aquatic plants, otherwise known as macrophytes, are important features of water quality management ponds and wetlands. Macrophytes perform many roles such as preventing erosion, providing a natural filtering system, removing nutrients from the water column, transferring oxygen to sediments to enhance the process of nitrogen removal (denitrification) and promoting organic matter breakdown. Macrophytes also provide habitat for aquatic and terrestrial species, increasing local biodiversity.

Maintaining good water quality is vital for establishment and the protection of macrophytes. For example, water that is highly turbid can block the sunlight needed for growth and high sediment loads can smother plants. Good water quality also protects biodiversity and ensures community recreation and aesthetics are maintained.

*Royal Spoonbill. Source: Ryan Colley*

# 9

# The impact of ACT's urban waterways on downstream water quality

*Murrumbidge River. Source: Ryan Colley*

Although the condition of the Murrumbidgee River is outside the scope of this report, its water quality downstream of the ACT provides an indication of the impacts of Canberra's urban waters on aquatic health, and consequently, the performance of water sensitive urban design measures to minimise the effects of urban areas and development on downstream water pollution.

The ACT Government has made a commitment to protect the Murrumbidgee River's water quality downstream of the ACT. In 2002, the Legislative Assembly passed a motion about water management, including an agreement that the water leaving the ACT via the Murrumbidgee River should be of no less quality than the water flowing into the ACT.

The impact of the ACT urban waters on water quality is determined by comparing ACT Government monitoring results for the Murrumbidgee River with sites upstream (Lobbs Hole) and downstream (Halls Crossing) of the ACT. This limits the findings presented here because although comparing sites upstream and downstream of the ACT provides an overall assessment, it does not enable an assessment of the individual impacts of Canberra's urban waterways on the Murrumbidgee River. This would require monitoring sites both upstream and downstream of the main urban water inflows.

Water quality for the Lobbs Hole and Halls Crossing sites is measured using in-situ (or in-river) water quality probes that record pH, electrical conductivity (a measure of salt concentration), dissolved oxygen, and turbidity. A benefit of these probes is that they record daily levels of pollutants as compared to routine monitoring which only provides monthly assessments. However, phosphorus and nitrogen are not assessed by these probes which is a significant knowledge gap for determining the impacts of Canberra's urban waters on the Murrumbidgee River.

It is important to note that the treated discharges from the Lower Molonglo Water Quality Control Centre (LMWQCC) will influence any comparisons between upstream and downstream water quality in the Murrumbidgee River. These discharges enter the river between the upstream and downstream sites used for this assessment. This means that some of the observed differences in water quality may be a result of the LMWQCC discharges, rather than the impacts of urban water inflows alone. An assessment of the treated discharges from the LMWQCC is not within the scope of this Investigation which is primarily concerned with the impact of Canberra's urban land environment on ACT waters.

Differences in water quality for the Murrumbidgee River upstream and downstream of the ACT is also influenced by pollutant inflows from non-urban waters such as Paddys River.

## Impacts of Canberra's urban waterways on the Murrumbidgee River

Water quality results for the period 2011 to 2021 show that turbidity is a significant issue for the Murrumbidgee River and one of the main impacts on downstream water quality caused by the ACT's urban waterways. Although turbidity guideline exceedances were common in the Murrumbidgee River sites assessed, in most years the number of exceedances were greater downstream of the ACT (Figure 9.1).[196]

Increased turbidity in the Murrumbidgee River downstream of the ACT is particularly evident during years experiencing periods of heavy rainfall such as 2012, 2020 and 2021. This indicates that the runoff from Canberra's urban and development areas, as well as from the rural catchment areas of Canberra's urban waters, are highly likely to be increasing turbidity by transporting greater loads of sediment into the ACT's waterways. Consequently, turbidity pollution from urban areas is not being effectively managed in the ACT nor are sediment control measures in land development areas **Chapter 12: Urban development and the ACT's lakes and waterways.** This is also supported by the urban waterway findings of this Investigation which has shown turbidity to be a concern for the Molonglo River, and the Tuggeranong, Ginninderra and Sullivans Creeks.

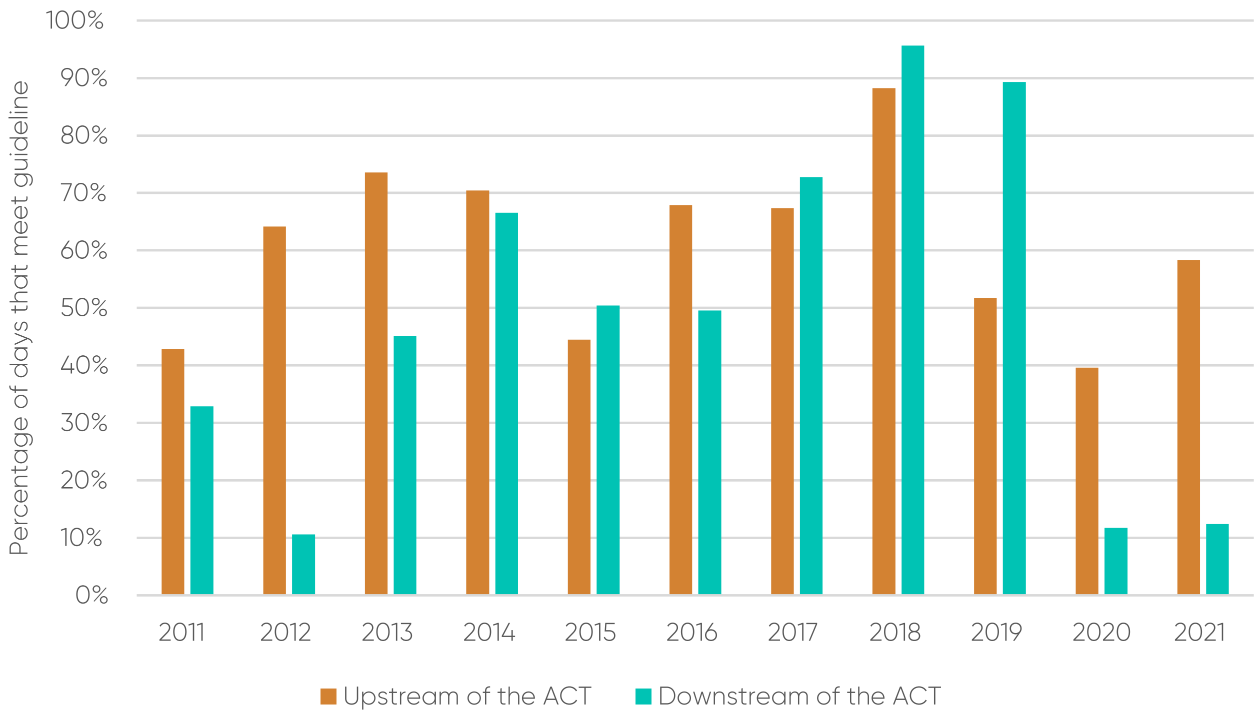



**Figure 9.1.** Percentage of days meeting the turbidity guideline level for the Murrumbidgee River upstream (Lobbs Hole) and downstream (Halls Crossing) of the ACT, 2011 to 2021.
**Data sourced from:** Environment, Planning and Sustainable Development Directorate.

Electrical conductivity increased downstream of the ACT from 2018 to 2020 with a significant percentage of days exceeding guideline levels (Figure 9.2), with further but much lower exceedances downstream in 2014 and 2015. In comparison, the upstream site experienced no exceedances for the entire 2011 to 2021 period. Increases in electrical conductivity are likely related to drought causing low flow conditions across the ACT. During such conditions, increased contributions from waterway baseflows and higher proportions of groundwater inflows tend to increase conductivity levels in urban waters. In addition, the discharge from the LMWQCC can be a substantial source of water for the Murrumbidgee River during periods of low flow. The treated sewage discharges can result in higher electrical conductivity concentrations (and other pollutants) when flows in the river are too low to significantly dilute these discharges. The return of wetter conditions in the second half of 2020 and in 2021 saw conductivity returning to acceptable levels.

196. The 2020 bushfires in Namadgi National Park are also likely to have increased turbidity levels, particularly in 2020. However, it is considered that this would not account for the increased exceedance of guidelines downstream of the ACT.

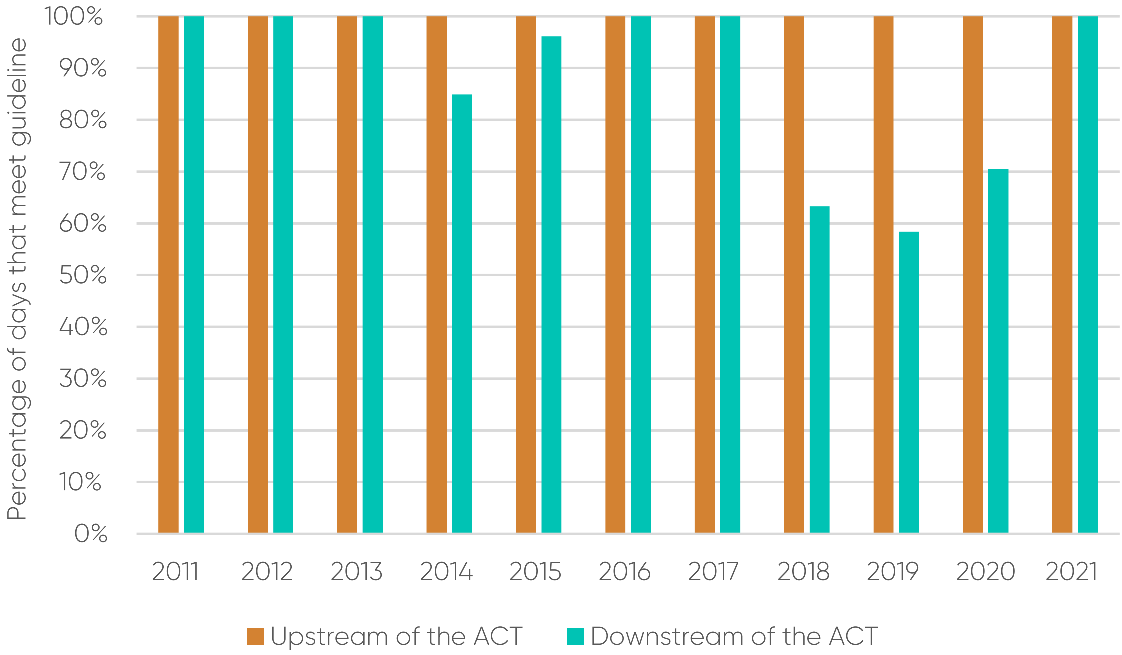



**Figure 9.2.** Percentage of days meeting the electrical conductivity guideline level for the Murrumbidgee River upstream (Lobbs Hole) and downstream (Halls Crossing) of the ACT, 2011 to 2021.

**Data sourced from:** Environment, Planning and Sustainable Development Directorate.

For other pollutants monitored, water quality results for the period 2011 to 2021 show that pH and dissolved oxygen in the Murrumbidgee River are comparable upstream and downstream of the ACT. Results also show that levels of pH and dissolved oxygen constantly meet guideline levels in most years.

Overall, water quality results show that Canberra's urban waterways are highly likely to be impacting the Murrumbidgee River downstream of the ACT. The impact is dependent on the type of pollutant with turbidity and associated sediment the most significant issue, as well as electrical conductivity in drought periods.

## Nutrient pollution

As previously noted, nutrients are not measured by the ACT Government at the sites used for this assessment. However, Waterwatch monitoring results show that nitrogen (as nitrate) concentrations are elevated in the Murrumbidgee River reaches downstream of the LMWQCC.[197] This increase is highlighted in the Waterwatch results for 2020 which show excellent condition nitrogen scores for Murrumbidgee River reach upstream of the treatment centre compared to a degraded condition for the two reaches downstream. Nitrogen concentrations (measured as nitrate) for the Murrumbidgee River downstream of the LMWQCC are typically more than 4 milligrams per litre and can be as high as 30 milligrams per litre compared to around 1 milligram per litre in the Murrumbidgee upstream of the ACT. A nitrate concentration of greater than 2.6 milligrams per litre is considered degraded under Waterwatch condition thresholds.

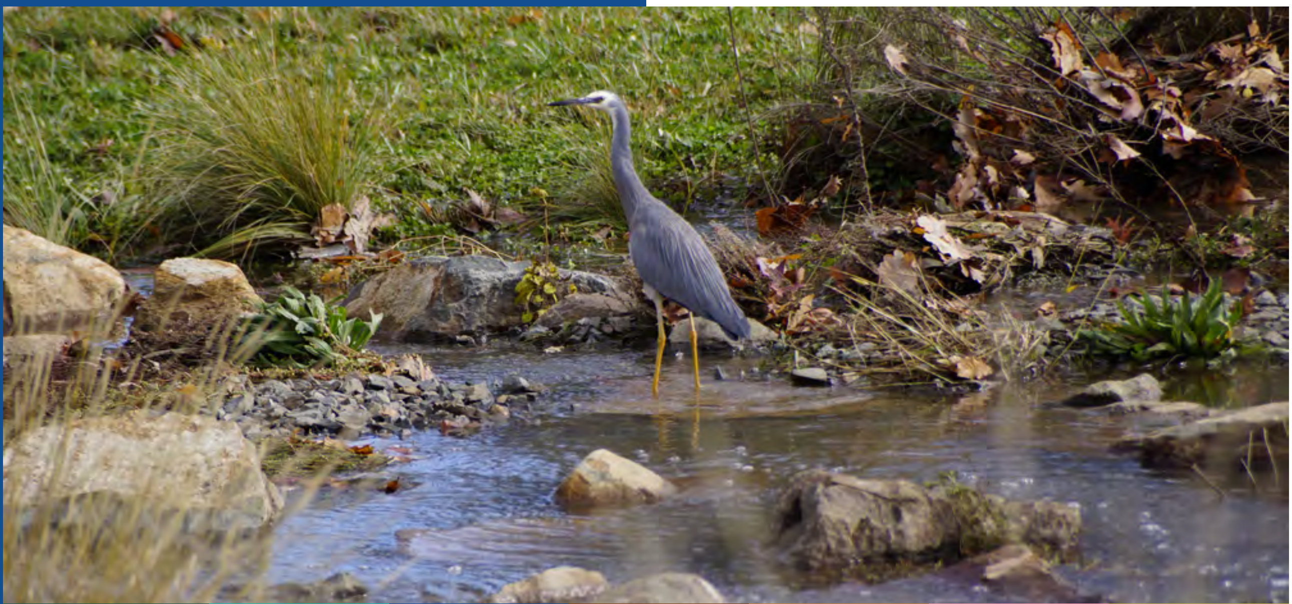
Whilst it is clear that the treated effluent discharges from the LMWQCC are the main source of the elevated nitrogen levels downstream of the LMWQCC, results from this Investigation show that nitrogen concentrations often exceed guideline levels in the Molonglo River, and the Tuggeranong, Ginninderra and Sullivans Creeks (see **Chapter 7 Canberra's urban waterways**). This suggests that these urban waters are at least contributing to the elevated nitrogen concentrations, even if they are not the main source.

197. O'Reilly, W., et al., 2021. *Catchment Health Indicator Program: Report Card 2020*. Upper Murrumbidgee Waterwatch, Canberra.

*Murrumbidgee River. Source: Ryan Colley*

10

# Management and governance of urban lakes and waterways



*Heron at Lyneham Wetland. Source: Fiona Dyer*

## Contents

As described in **Chapter 4 Contemporary values and expectations of urban lakes and waterways**, Canberra has adopted diverse approaches to stormwater treatment, with a range of treatment systems and a range of design styles implemented over the years. This complexity is also reflected in the management and governance arrangements relating to urban lakes and waterways. In addition to ACT Government stakeholders that have direct responsibility and influence over the management of Canberra waterways, there are numerous community stakeholders that include but are not limited to community organisations, not–for–profit groups, private landholders and federal Government departments.

## 10.1 ACT Government roles and responsibilities

This section provides a simple overview of which parts of government are responsible for which parts of urban water management. Responsibilities span four ACT Government directorates, and often multiple different teams within those directorates, and the Commonwealth Government's National Capital Authority. These different entities must coordinate and collaborate in order to effectively implement policies in what is often a very complex operating environment. Even within the same directorate, memoranda of understanding are sometimes required between different teams to ensure responsibilities are clear.

The **Transport Canberra and City Services Directorate** (TCCS) is responsible for practical management and maintenance of stormwater infrastructure, including:

- urban ponds, lakes and wetlands on public land, and the greenspace surrounding them
- stormwater drains and channels, and
- gross pollutant traps.

Maintenance includes cleaning, dredging, infrastructure repairs, vegetation management (including mowing), litter removal and street sweeping. TCCS sets the design standards for public infrastructure, including that built by other entities. It also runs the inner north reticulation network  stormwater harvesting and irrigation scheme.

The **Environment Protection Authority** works within a regulatory framework for environmental protection and is responsible for protection of waterways through enforcement of pollution controls, including:

- approving sediment control plans and other water quality protection measures for construction, and inspecting construction sites for compliance
- investigating pollution events affecting waterways, e.g., contamination by a business or individual, and
- granting and enforcing authorisations relating to waterway and water quality protection, e.g., discharge licences for sewage treatment plants (see **Chapter 12 Urban development and the ACT's lakes and waterways**).

The **Environment, Planning and Sustainable Development Directorate** (EPSDD) is responsible for planning, policy, monitoring and conservation functions relating to urban waterways including:

- developing the policies which underpin planning, development, and environmental and waterway protection in the ACT
- approving development and construction in the ACT
- building stormwater infrastructure on public land (Healthy Waterways Project)
- water quality monitoring in urban lakes and waterways, and
- conservation and monitoring of aquatic plants and animals including fisheries management.

The **ACT Health Directorate** is responsible for monitoring recreational water quality to ensure public safety at the ACT's swimming and boating spots.

The **National Capital Authority** is responsible for Lake Burley Griffin and Scrivener Dam, including water quality, and 38 per cent of its shoreline (the rest is managed by ACT Government, with a small proportion managed by Government House and the Royal Canberra Golf Course).

It should be noted that Icon Water plays no role in urban stormwater management; its responsibilities are limited to the supply of drinking water which is sourced from rural catchments, and sewerage services.

## Street sweeping

TCCS is responsible for the ACT's street sweeping program. Keeping Canberra's streets and gutters clear of leaves is no easy task, especially in established suburbs with mature deciduous trees which drop large amounts of leaves each autumn. TCCS has five street-sweeping trucks, and during the busiest times of year these drive thousands of kilometres each month collecting leaves.

Recognising the importance of making their street sweeping program as efficient as possible, TCCS recently undertook a project to optimise the effectiveness of how their street sweepers and drivers are deployed. The project mapped every street segment in the urban area of Canberra and assigned attributes based on tree species, canopy coverage, land use type and water quality indicators. This allows TCCS to focus its street sweeping efforts on point-source pollution management within leafy suburbs and other areas with a build-up of debris during times of high leaf fall.

The street sweeping program prevents large quantities of leaf litter entering the stormwater system. This is one of the most effective ways of preventing poor water quality in our urban lakes and wetlands.

## 10.2 Incorporating Ngunnawal Knowledge into water policy and management

The ACT Government's progress on incorporating the knowledge of Ngunnawal Traditional Custodians into water management and assessment is discussed here. It should be noted that this applies to all waters throughout the ACT. Ngunnawal knowledge is important for the management of all waters in the ACT region.

The recognition and integration of Ngunnawal Traditional Knowledge into environmental management is essential for improving the condition of the ACT's waterways, including the restoration of those waterways highly modified by urban development, and the creation of effective water sensitive urban design. The benefits that First Nations knowledge brings are many, including the understanding of ecosystems and biodiversity, and their responses to changes in climate, seasons and events such as fire and drought. But perhaps most importantly, the inclusion of Traditional Knowledge is an essential step towards determining whether Ngunnawal cultural water values are being sustained in the ACT.

EPSDD is working to increase the involvement of Ngunnawal Traditional Custodians and the use of their Knowledge in natural resource management. This includes the identification and agreement of cultural water values, ongoing consultation with the Ngunnawal Community, and increased opportunities for First Nations people in environmental management-related roles. Much of this work is being done in consultation with the Dhawura Ngunnawal Committee which is a key forum for consultation with Ngunnawal Traditional Custodians in the ACT. The Committee will be critical for informing the development of a unified framework for cultural indicators relating to cultural water, as well as development of a seasonal calendar.

The *ACT Water Resource Plan for Surface and Groundwater*[198] identifies the objectives and outcomes of the Ngunnawal Traditional Custodians in relation to managing water resources. These are based on cultural values and uses that were identified through consultation with the Ngunnawal Traditional Custodians and informed by Aboriginal Waterway Assessments. The Water Resource Plan is an Australian Government policy document, developed under the *Water Act 2007* (Cth) and the Murray-Darling Basin Plan 2012.

The Aboriginal Waterway Assessments have been conducted since 2015, and most recently in December 2020, facilitated by EPSDD. The assessments have contributed to an initial set of values and uses as recognised by the Ngunnawal Traditional Custodians. EPSDD is continuing to work with the Ngunnawal community to conduct these assessments, and to build a shared understanding of the cultural values and uses for future natural resource management.

The Aboriginal Waterway Assessments have provided opportunities for Ngunnawal Traditional Custodians to work together on Country along with other Traditional Custodian groups to collect detailed information about the cultural values of ACT waters.

198. Environment, Planning and Sustainable Development Directorate, 2019. *ACT Water Resource Plan for Surface and Groundwater*. ACT Government, Canberra.

The protection of cultural values and uses is supported through the *ACT Water Strategy 2014–44 and Implementation Plan*,[199] the *ACT Environmental Flow Guidelines*[200] and land and catchment management plans. Maintaining water flows and undertaking activities to improve water quality contributes to many of the cultural values and uses that were identified through the Aboriginal Waterway Assessments. The *ACT Water Strategy 2021 Report Card*[201] included a new indicator for future reporting on the recognition of cultural water values and uses in water management and planning.

To provide further opportunity for involvement in environmental planning issues, EPSDD has identified the need for a First Nations representative on the ACT and Region Catchment Management Coordination Group. Incorporating cultural land and water management practices into ACT Government activities is also being supported by the employment of Ngunnawal people in a variety of roles throughout EPSDD. In 2021, this included recruitment into new roles in the Parks and Conservation Service, Natural Resource Management, Conservation Research and Water Policy.

In October 2021, the first Ngunnawal water policy officer was appointed to EPSDD. The intent of this position is to improve the health of the region's waterways and environment through a Ngunnawal cultural perspective. Minister for Water, Shane Rattenbury MLA, said that 'First Nations knowledge is critical to our understanding of the natural environment and sustainable management of the land and water'.[202]

In November 2021, a new nature reserve, Namarag, in the Molonglo River Reserve was opened, near the new suburbs of Whitlam and Denman Prospect. Namarag means 'wattle' in Ngunnawal language and the design of the nature reserve was guided by the Ngunnawal community. This is to ensure that the area celebrates the culture appropriately and shares the Ngunnawal story through tourism and education.[203] Over 10,000 trees, shrubs and other plants have been added to the reserve by Greening Australia and more than 2,000 tonnes of hardwood logs salvaged from Canberra's urban forest tree program. This recognition and incorporation of Ngunnawal culture into the river nature reserve represents a significant step forward in terms of including Traditional Knowledge in ongoing environmental management.

EPSDD have indicated that they will also be conducting new projects to:

- Develop a Cultural Resource Management Plan in response to the 2019 review of the ACT's *Fisheries Act 2000* and subsequent changes to the *ACT Nature Conservation Act 2014* to support improved access to natural resources for Ngunnawal Traditional Custodians.
- Continue Aboriginal Waterway Assessments to further develop shared understanding of cultural values and uses of our waterways.

199. Environment, Planning and Sustainable Development Directorate, 2019. *ACT Water Strategy 2014–44 and Implementation Plan*. ACT Government, Canberra.
200. Minister for the Environment and Heritage, 2019. *ACT Environmental Flow Guidelines*. ACT Government, Canberra. https://www.legislation.act.gov.au/di/2019-37/
201. Environment, Planning and Sustainable Development Directorate, 2021. *ACT Water Strategy 2021 Report Card*. ACT Government, Canberra.
202. Canberra City News, 2021. *Bradley Bell appointed as first Ngunnawal water policy officer*. https://citynews.com.au/2021/bradley-bell-appointed-as-first-ngunnawal-water-policy-officer/, published on 27 October 2021.
203. Canberra City News, 2021. *New nature reserve opens in Molonglo*. https://citynews.com.au/2021/new-nature-reserve-opens-in-molonglo/, published on 3 November 2021.

- Conduct investigations to define Cultural water flow requirements that can be incorporated into the 2023–24 review of the *Environmental Flow Guidelines*.
- Incorporate cultural values and uses within Nature Park Management Plans, through their periodic reviews. The latest reserve management plan to be updated, the *Canberra Nature Park Reserve Management Plan*[204] includes substantial references to First Nations culture within the various reserves of Canberra Nature Park, a vast improvement on previous plans.

These activities will be undertaken with the support and guidance of the Dhawura Ngunnawal Caring for Country Committee to actively engage the Ngunnawal Traditional Custodians.

## 10.3 The community's role in water management

This section includes special-interest groups, and the general public in its considerations of 'community'; Traditional Custodians are considered in the section above and in **Chapter 3**. More detail about the different ways in which the community values Canberra's urban waterways can be found in **Chapter 4**.

Most of the water that flows into Canberra's waterways comes from urban catchments, which means it consists largely of run-off from the road network, other public spaces and private gardens. As a result, how these spaces are used by the public has a direct impact on the pollution that enters our lakes and waterways. Schirmer and Mylek[205] found in their survey that public attitudes to potential measures for reducing impacts on waterway health varied a great deal, suggesting that persuading the broader Canberra community to modify their behaviours to better protect water quality protection is not straightforward. However, the appreciation that the Canberra community has for its urban lakes and creeks is reflected in the role that members of the general public play in looking after them.

204. Environment, Planning and Sustainable Development Directorate, 2021. *Canberra Nature Park Reserve Management Plan*. ACT Government, Canberra.
205. Schirmer, J. and Mylek, M., 2016. *Water quality and the community: understanding the views, values and actions of residents of the ACT and surrounding region.* University of Canberra, Canberra.

## Community groups

Waterways in the ACT are often the focus of community-based efforts to better conserve and protect the natural environment. Many wetlands and ponds have dedicated community groups caring for them, collecting litter and weeding at the sites, and there are several citizen science programs in the ACT region focussed on water quality and aquatic species. Other volunteer groups assist more generally with protecting Canberra's urban waterways through cleaning up rubbish and other pollutants, stabilising the landscape through planting vegetation, or running education programs to teach the public about how their everyday actions can affect our lakes and rivers.

Community involvement in waterway management and protection is strongly supported by ACT Government, with funding provided through a variety of grant programs. Some larger community groups are also directly funded for water-related projects and programs. EPSDD and TCCS both run their own volunteering programs, with staff dedicated to supporting volunteer groups across a range of sites and activities.

The Commissioner for Sustainability and the Environment recently published a web-based report about the contributions made by volunteers to environmental management in the ACT, including substantial contributions to protection and conservation of wetlands and waterways. This report can be viewed at www.actenvirovolunteers.org.au.

## Catchment groups

The ACT's three community-based catchment groups are the leading organisations in the ACT which facilitate engagement between the community and urban waterways. Each group is a not-for-profit organisation which provides support, connections and advocacy for its members. Their membership is made up of ParkCare and Landcare groups, Waterwatch and Frogwatch volunteers, and individuals with an interest in protecting their local environment. The catchment groups work in partnership with many different non-government organisations, rural landholders and government agencies to deliver environmental projects. They are also integral to the Upper Murrumbidgee Waterwatch program as each catchment group employs a Waterwatch Coordinator who manages the program for their area. Ginninderra Catchment Group also employs the Frogwatch Coordinator and runs the ACT Frogwatch Program. The catchment groups are substantial repositories of local environmental knowledge and expertise through their volunteer networks.

In recent years, the catchment groups have received funding from the ACT Government specifically to engage with the community around the recently-constructed urban wetlands, rain gardens and stormwater ponds that were built as part of the Healthy Waterways Program. They were also engaged as community partners for the ACT Government's H2OK water education program. Under these funding agreements, they have supported the establishment of new Landcare groups at wetland sites, run educational walk-and-talk events, engaged with schools to teach students about water quality, undertaken drain stencilling and surveys about community behaviour and conducted social media campaigns about water quality.

**Ginninderra Catchment Group** (GCG) was the first catchment group to be formed in the ACT, established in 1996 by community members looking to support the on-ground groups working around Ginninderra Creek. It operates predominantly in the Ginninderra Creek catchment, in the north-west of the ACT, working with over 25 on-ground Landcare and ParkCare groups in the area. It also runs its own projects and programs. Over the years, GCG volunteers have substantially revegetated the urban stretches of Ginninderra Creek, championed the restoration and protection of endangered native temperate grassland, and cemented the success of the ACT Frogwatch citizen science program.

**Southern ACT Catchment Group** (SACTCG) was formed in 2002 at the instigation of local ParkCare groups and the ACT Government. SACTCG works with around 27 Landcare and ParkCare groups who are members of the catchment group, helping them to plan, deliver and access funding for on-ground works. Unlike the other catchment groups, SACTCG does not work within the catchment of a river or creek but rather has a 'social catchment' that spans the southern suburbs of the ACT and includes farmland and Namadgi National Park.

**Molonglo Conservation Group** (formerly Molonglo Catchment Group) was formed in 2003 to support on-ground groups in the Molonglo and Queanbeyan River catchments in NSW as well as the ACT. It has traditionally focussed on landscape-level planning, working with landholders and volunteers across its region.

### Lake Burley Griffin Guardians

This volunteer group aims to preserve the social and historic values of Lake Burley Griffin and its surrounds, and to protect its ecological values including water quality. To this end, group members are actively engaged with development and land use practice changes around the lake and in its catchment. They work to promote sympathetic and sensitive development appropriate to the lake's aesthetic value and to minimise negative impacts on its amenity and ecology. They achieve this through engaging with relevant government agencies and lake and landscape managers.[206]

### Trash Gather

Trash Gather is a youth-led clean-up initiative gathering people to protect and restore the local environment. Since they were formed in 2017, Trash Gather has expanded with support from hundreds of local volunteers by hosting regular rubbish clean ups across Canberra. For more information see the Trash Gather website.[207]

206. Website of Lake Burley Griffin Guardians: https://lakeburleygriffinguardians.org.au/
207. Website of Trash Gather: https://www.trashgather.org/

## Clean Up Australia Day

Clean Up Australia Day is a well-known national scheme which supports members of the community to pick up rubbish from their local area. In the ACT, many community organisations, schools and workplaces organise a litter clean-up event under the banner of Clean Up Australia Day and remove tonnes of rubbish from our environment which would likely otherwise end up in one of our waterways. In 2020, over 17,000 volunteers registered to clean up 146 individual sites, and removed over 314 ute-loads of rubbish. An excellent overview of Clean Up Australia Day's impacts in the ACT for 2020, can be found in its annual Rubbish Report.[208]

## Woodlands and Wetlands Trust

The Woodlands and Wetlands Trust manages Mulligans Flat Woodland Sanctuary and Jerrabomberra Wetlands to ensure rich and diverse environments for current and future generations. They run a number of volunteer programs which enable people to get involved with managing these unique ecosystems and monitor their flora and fauna.

## ACT Government Volunteering Programs – ParkCare Groups and Urban Parks and Places Groups

The ACT Government runs two volunteer programs which enable the community to get involved with protecting and enhancing public spaces in and around Canberra. The ParkCare Program, run by the Parks and Conservation Service, focuses on nature reserves. The Parks and Places Volunteering Program, run by the City Services Division, focusses on other urban open spaces such as local parks and the areas surrounding urban lakes; these groups are often called Landcare groups.

Many Landcare and ParkCare groups in the ACT contribute to the protection of urban waterways through their work on Canberra's parks and reserves. Planting native vegetation, removing weeds and controlling erosion all make a big difference to the resilience of the city's soils and ecosystems, which in turn leads to healthier waterways.

In addition to their 'formal' work on managing urban nature reserves and open spaces, these groups act as eyes and ears on the ground for ACT Government land managers, sharing their observations with rangers and other staff responsible for the waterways.

As part of the ParkCare and Parks and Places volunteering programs, many of the ACT's wetlands, ponds and creeks have dedicated volunteer groups whose members actively work to enhance the ecological and amenity values of the waterbody and its surrounding area. These groups with specific ties to a waterbody or creek are listed below.

208. ACT Annual Rubbish Report 2020. https://irp-cdn.multiscreensite.com/ed061800/files/uploaded/2020%20ACT%20Fact%20Sheet.pdf

### Friends of Jerrabomberra Wetlands

This group's activities include weed removal, erosion control, revegetation and other land management tasks. They also run a range of community activities including guided walks and science forums.

### Park Carers of Southern Murrumbidgee

An informal, enthusiastic group which takes care of an area on the Murrumbidgee River from Point Hut Crossing to Pine Island. Their activities include planting, seed collection, weeding and erosion control.

### North Belconnen Landcare Group

This group has been operating since 1994 and works in the Ginninderra Creek corridor. The group clears up rubbish, weeds and plants to enhance the natural values of the creek.

### Friends of Lower Stranger Pond Landcare Group

This group aims to improve the natural areas in Bonython centred on Stranger Pond, including its connectivity to nearby areas such as Pine Island Reserve and Mt Stranger.

### Banksia St Wetland Group

This group works to keep the Banksia St Wetland free from weeds and rubbish.

### Dickson Wetland Weeders

This group works to keep the Dickson Wetlands free from weeds and rubbish.

### Emu Creek Park Landcare

A Landcare group that works on bush regeneration, weeding and planting focussed around a drainage line close to Lake Ginninderra.

### Flea Bog Flat Landcare

A Landcare group caring for the Flea Bog Flat area and its flora and fauna, and researching and preserving its rich heritage.

### Giralang Pond Landcare

A Landcare group whose activities focus on weed management, planting native vegetation, erosion control and community awareness-raising and education.

### Holder Wetlands Landcare

A group formed to look after and protect the Holder Wetlands. Volunteers weed, plant and care for trees and shrubs, create wildlife habitat and keep the wetlands tidy for people to enjoy.

### Tuggeranong Lake Carers

This group was established to promote a healthier lake in Tuggeranong. Key activities include organising clean-up events and advocating for water quality improvement measures for the lake.

### Friends of Mawson Ponds

A group formed to look after and protect the Mawson Wetlands, and improve habitat connectivity in the surrounding area through planting native species.

### Friends of Molonglo green spaces

A Landcare group that cares for green spaces large and small in the new Molonglo suburbs, helping to protect the Molonglo River.

### Sullivans Creek Microforest

A group set up to plant and tend to the new microforest in Lyneham, near the banks of Sullivans Creek.

### Friends of Narrabundah Wetlands

A group formed to look after and protect the Narrabundah Wetlands.

### Croke Place Lions Landcare

This group was established to care for the new Croke Place Wetlands and is working to improve the surrounding area with native plantings.

### Friends of Yerrabi Ponds

A new group focussed on the green spaces around Yerrabi Ponds and improving the water quality.

### Half Acre Wood and Melba Wetlands Landcare

A new group formed in 2021 whose members care for the recently constructed Melba Wetlands and the adjacent woods.

### Jaramlee Landcare Group

This group's work is focussed on the Ginninderra Creek Corridor, tributaries, ponds and open areas, in and around the area known as Jarramlee Park Estate, in Dunlop.

### Umbagong Urban Landcare Group

Formed in the 1980s, this group's activities include weed management; native grassland, riparian, and woodland restoration; rubbish removal; erosion control; and community education.

### Crace Landcare Group (Crace Wetlands)

This group was formed to look after the Crace Wetlands and surrounding area through rubbish removal as well as planting trees and shrubs to create wildlife habitat and increase site amenity value.

### Macgregor Landcare (Ginninderra Creek)

This group works in the Ginninderra Creek corridor, with regular events to clear up rubbish and weeds and planting to enhance the natural values of the creek.

### Friends of Yerrabi Pond

A community Landcare Group established to look after Yerrabi Pond in Gungahlin, through community consultation on management and on-ground Landcare activities.

### Friends of Harrison Wetlands

A Landcare group whose activities focus on community education and engagement at Harrison Wetlands, as well as weed management, planting native vegetation and amenity improvements.

### Friends of Flea Bog Flat (Bruce)

This group has been re-establish to care for a remnant bog in Bruce, focusing on rubbish removal as well as weed control and biodiversity assessments to enhance the local habitat values.

Similar groups have also been established very recently at Lawson and Isabella Pond. Residents groups, such as those at Oaks Estate and Curtin, often also have environment sub-groups which look after their local riverbank or wetland.

See Change and the Canberra Environment Centre also run a range of education campaigns and workshops which contribute to water quality protection through the promotion of actions Canberrans can adopt at home, such as composting and other sustainable gardening practices, and minimising their rubbish production through recycling and repair.

Other lake and waterway users such as sailing, rowing or canoeing clubs, scout groups, and walking, running or cycling groups also play a role through activities such as clean-up days and raising awareness about the importance of urban waterbodies for recreation and amenity. Anglers groups are also concerned about water quality and protecting the health of fish populations.

## Community actions for better stormwater quality

Because urban catchments are responsible for much of the pollution entering Canberra's lakes and waterways, the community has an important role in improving stormwater quality. The organic matter from urban catchments has been identified as a major cause of blue-green algae blooms and other water quality issues. This includes soil, leaves and other green waste, and animal faeces that are washed off urban areas and into stormwater systems. Actions taken by the community to remove leaves and other organic material from lawns, nature strips and road gutters will significantly improve the water quality of Canberra's urban lakes and waterways and reduce the number of recreation closures in Canberra's lakes. The community can also reduce the amount of nutrients in stormwater by minimising the use of fertilisers on gardens and lawns.

## Citizen Science Programs

### Upper Murrumbidgee Waterwatch

Waterwatch is a very successful citizen science program that has been running for over 20 years. Its 200+ volunteers collect water quality data from 220 sites at waterways across the ACT region. Volunteers are provided with scientific equipment to take out into the field, and measure nitrogen, phosphorus, dissolved oxygen, electrical conductivity, pH and turbidity. This information can tell us a lot about the health of a waterway and is complemented by other data collected through the program, such as surveying the vegetation around the site and the aquatic invertebrates living in the water. The dataset collected by Waterwatch volunteers has been found by researchers at the University of Canberra[209] to be comparable to that collected by professional field technicians.

The Waterwatch program also runs two seasonal citizen science projects, Platypus Month and a Carp monitoring program to collect data about when and where these invasive feral fish breed. Platypus month surveys attract around 300 volunteers each year and have added greatly to our understanding of how many of these charismatic creatures live in the waters around the ACT.

Waterwatch is facilitated by the ACT Government, with a staff member working in the ACT Natural Resource Management team. Three program coordinators, also funded by ACT Government, are based in the ACT catchment groups, with a fourth in Cooma. The role of these coordinators is to support the volunteers and make sure that they have the skills and equipment they need to carry out their water testing each month.

Each year, Waterwatch publishes its Catchment Health Indicator Program report (or CHIP), which reviews and summarises all the data collected through its surveys throughout the year. This information is used to give each section of a waterway a score to indicate its health. The fact that Waterwatch has been running for such a long time, and has such a broad reach, provides an overview of water quality in the ACT region across time and space which is unmatched by other datasets. This is invaluable to water scientists and policy makers in understanding more about how our waterways function, and how this reflects changes in the landscape and climate.

The Upper Murrumbidgee Waterwatch program is funded and facilitated predominantly by EPSDD, with some additional funding from Icon Water. It is a highly regarded and successful example of a strong collaboration involving the community, government and industry.

### ACT Frogwatch

This program is an ACT-wide initiative which gives volunteers the skills to identify frog species by their calls, allowing them to monitor frog populations. It was established in 2002 to build understanding of frogs in the ACT, engage and educate people about them, and help protect these amazing amphibians.

209. Harrison, E., et al., 2013. Waterwatch data and catchment health indicator data review. Prepared for ACT Government. https://www.act.waterwatch.org.au/__data/assets/pdf_file/0010/1446697/act-waterwatch-data-review-2013.pdf

The program is run by Ginninderra Catchment Group, with funding from the ACT Government among others.

Volunteers can provide information about their observations throughout the year through the FrogWatch portal on Canberra Nature Map.[210] The highlight of the Frogwatch year however, is the annual census where almost 200 sites are surveyed for frogs by over 200 volunteers within one month. This provides an annual snapshot of frog populations in the ACT, allowing scientists to track changes over time. Data from Frogwatch surveys is also being used to measure the effects of climate change, and to determine whether wetlands constructed in urban areas provide good habitats for wildlife.

As well as its citizen science focus, Frogwatch has a strong educational element. Schools can raise their own tadpoles using one of the Frogwatch tadpole kits or have an expert come to the classroom to talk to them about frogs.

Frogwatch has also spawned other citizen science initiatives aimed at finding out more about the creatures that live in Canberra's waterways.

## Government consultation with community

The general community in the ACT is afforded a number of avenues for providing input into water-related decisions. The public, community groups and other stakeholders are able to directly comment on some government policies and on developments through the online platforms listed below. Additional efforts to promote and increase awareness of these avenues for the public to provide feedback to government would make them more useful to the Canberra community.

- The ACT 'YourSay' website, which operates as a hub for community interactions with the ACT Government. It facilitates communication about significant planning and policy changes, strategies and new directions. It provides any member of the public with the opportunity to comment on these as they are developed by Government.
- Environmental Impact Statements for major developments where a detrimental impact on the environment is anticipated are publicly notified online.[211] The website enables any member of the public to comment on such developments and proposed mitigation measures for their impacts.
- Members of the public can report any adverse environmental impacts they observe to the Environment Protection Authority via Access Canberra by calling 13 22 81 or through their online form.[212] This includes pollution of waterways.

210. Frogwatch ACT and Region website: https://frogwatch-act.naturemapr.org/
211. Environmental Impact Assessment website, ACT Government: https://www.planning.act.gov.au/development-applications/da_assessment/environmental_assessment
212. Access Canberra Feedback and Complaints website, ACT Government: https://www.accesscanberra.act.gov.au/s/feedback-and-complaints

The ACT Government has begun to explore using deliberative democracy for environmental issues and continuing this was recommended in the *2019 ACT State of the Environment Report* (recommendation 8). Deliberative decision making has been emerging as an aspect of best practice to improve stormwater management in Sydney.[213] A recent example of this in the ACT was the Better Suburbs forum run by TCCS in 2018. If this approach continues it will assist with fostering community interest and buy-in in directing government priorities.

While the ACT Government can be commended for funding community groups to run some elements of its community engagement work on water management, the prescriptive conditions which accompany this funding can stifle genuine community innovation and ownership. Weaknesses in effective community engagement are further compounded by the many different areas of government which community groups must engage with in order to get traction on urban water management. Section **11.2** discusses the governance arrangements in place for water management in the ACT, including how the community is involved.

## 10.4 Governance arrangements for water and catchment management

This Investigation has found that responsibility for water management is dispersed across multiple agencies and without clear accountability for catchment-wide planning and management at an urban scale, and for making strategic decisions for the lakes, ponds and waterways as part of a connected system. The effectiveness of the existing governance arrangements for delivering holistic and coordinated water policy and programs are discussed in Chapter 11.

### 10.4.1 ACT and region water groups, forums and networks

In spite of the absence of an overarching governance mechanism for water management in the ACT, there are a number of other groups and coordination networks focussing on the subject of water management across the region. This demonstrates the high level of interest in water both within the ACT Government and from community and industry stakeholders. It is also illustrative of the genuine desire held by many who work in the water space to work collaboratively and with transparency. However, the number of entities operating in the water space results in a complexity which can in itself be a barrier to effective water governance and the development of a shared vision for water quality and ecological health.

This section provides an overview of some of the organisations working to improve coordination of water and catchment management in the region. These include government, non-government and a combination of both.

Within ACT Government, there are various water-related taskforces and working groups which are often driven by a narrow agenda within the water space such as stormwater infrastructure management or

213. Brown, R. R., Ryan, R., and Ball, J. E., 2000. *A participative planning methodology: Urban stormwater quality management at the watershed*. Watershed Management and Operations Management 2000, 1-10.

water efficiency. These types of targeted working groups can be an efficient way to address a specific purpose, however the reporting line and decision-making responsibility for these groups is not always clear. The Senior Executives Water Group, as an overarching governance forum, previously brought together senior managers from across different areas with responsibility for water management, however this group is not operating at present.

The Environment, Planning and Sustainable Development Directorate consults on a semi-regular basis with the **Environment and Planning Forum**[214], whose members are representatives from each of Canberra's community councils, the Conservation Council and a number of other significant stakeholder groups with an interest in planning and urban amenity. Its defined purpose is:

> *to contribute to outcomes through discussion on planning and environment policy and program matters that are of strategic importance to the ACT; and to provide input to policy matters across the broad range of activities carried out by the Environment, Planning and Sustainable Development Directorate.*[215]

The forum provides an opportunity for interested stakeholders to contribute to government policy and programs. It operates at a high level, and while matters relating to water are raised periodically at this forum as they become pertinent there is no specific focus on urban water management. At the time of writing no minutes from this forum have been published since August 2020.

The **ACT and Region Catchment Management Coordination Group** is a statutory body and an example of cross-institutional and cross-jurisdictional collaboration on water and catchment management. It is made up of representatives from ACT Government, neighbouring NSW local councils and other NSW government entities, the Australian Government and industry. The Group was established under the *Water Resources (Catchment Management Coordination Group) Amendment Act 2015*, which stipulates the inclusion on the Group of a community representative, and that the chair be independent and community based. The main function of the Group is *to 'advise the Minister on matters relating to water catchment management in the ACT and the Australian capital water catchment region.*[216] Specifically, this includes identifying regional catchment priorities, building partnerships (including for regional investment) and assessing the potential impacts of specific developments of events. The Group has developed and oversees the *ACT and Region Catchment Strategy*[217] which is described further in **11.1 Summary of policies, plans and strategies relating to urban water management**.

The **Upper Murrumbidgee Catchment Network** is a community-led network which fosters information sharing and discussion about catchment management in the Murrumbidgee River catchment upstream of Burrinjuck Dam. Its membership includes many community groups, both ACT and NSW Government departments, and representatives from industry groups and corporations with an interest in natural

214. Environment and Planning Forum website: https://www.planning.act.gov.au/talk-with-us/boards-councils-committees-panels-and-other-bodies/planning-and-development-forum
215. Environment, Planning and Sustainable Development Directorate, 2019. *Environment and Planning Forum Terms of Reference*. ACT Government, Canberra.
www.planning.act.gov.au/__data/assets/pdf_file/0014/1380200/environment-and-planning-forum-terms-of-reference.pdf
216. ACT Government, 2015. *Water Resources (Catchment Management Coordination Group) Amendment Act 2015*. ACT Government, Canberra.
217. Environment and Planning Directorate, 2016. *ACT and Region Catchment Strategy*. ACT Government, Canberra.

resource management. It aims to foster collaboration and communication between its members to achieve positive outcomes in water and land management.

The **Conservation Council ACT Region** is a peak body for environment groups in the ACT. It advocates for the protection of the natural environment across a wide range of areas, and is particularly active in holding the ACT Government to account on urban planning and development matters that have environmental impacts, including on water. It also supports its member groups on matters of concern to them.

**Landcare ACT** is a peak body for Landcare and Parkcare in the ACT, with urban, rural and First Nations landcarers among its members. It advocates for its members on a range of issues including management of urban open spaces and the waterways and wetlands within them.

The **Dhawura Ngunnawal Caring for Country Committee** provides guidance, direction, advice and decisions on the management of Ngunnawal Country.

The groups listed above all facilitate engagement by members of the community and stakeholder groups (some of these are described in more detail in the following sections of this report) with Government on water and catchment management. While it is clear there are many avenues for community engagement with Government on water management issues, what is lacking is a way for the diverse perspectives and priorities represented across these various forums to be brought together and presented to government decision-makers. This mirrors the internal barriers to effective collaboration within the ACT Government which are explored further in Chapter 11. As a result, there is some frustration among the community with regard to the disjointed approach of the ACT Government when it comes to management of Canberra's urban lakes and waterways.[218]

## 10.5 Management of main urban lakes and waterways

### 10.5.1 Lake Burley Griffin

Lake Burley Griffin is managed by the National Capital Authority (NCA) on behalf of the Commonwealth of Australia, which has responsibility for the lake itself and some of the foreshore area. However, its management responsibilities do not include catchment areas of the lake other than those on National Land. The ACT and NSW Governments (including the Queanbeyan-Palerang and Cooma-Monaro regional councils) are responsible for managing the vast majority of the catchment areas that drain into Lake Burley Griffin.

*Despite the numerous entities managing the lake's catchment and sub-catchments, there is no mechanism for overall coordination between them.*

218. Personal commentary from community members consulted during the production of this report, 2021.

The ACT Government manages catchments on ACT land, including the Molonglo River sub-catchments of Kowen, Fyshwick, Central Molonglo, and some streams flowing directly into the lake, such as Jerrabomberra and Sullivans Creeks, and drainage lines in ACT urban areas flowing into the lake. The ACT Government also manage fish stocking in Lake Burley Griffin, although this is funded by the National Capital Authority.

Community organisations, such as Waterwatch and Landcare, and private landholders also play a valuable role in the management of the lake's water quality and aquatic health through their catchment management and monitoring activities.

## Management of Lake Burley Griffin

Although the National Capital Authority has statutory responsibility for the management of Lake Burley Griffin, it is custodian of just 38 per cent of the shoreline. The ACT Government is responsible for managing 57 per cent of the shoreline, with Government House managing 4 per cent, and the Royal Canberra Golf Course managing around 1 per cent. This means that within the ACT, the management of existing and potential impacts on the lake's health is predominantly the responsibility of the ACT Government. However, because the majority of lake Burley Griffin's catchment is outside of the ACT, the management of aquatic impacts in NSW waters is also vital for the health of Lake Burley Griffin.

The approach to managing the lake is set out in the *National Capital Plan*,[219] which identifies the lake as an integral part of the design of Canberra and a key focus of planning for the National Capital. The plan identifies a series of objectives for Lake Burley Griffin and its foreshores that aim to enhance and develop the connection to the lake. These rely on the protection of water quality in the lake, a point that is explicitly noted in the plan through objectives to *'maintain the water quality in a manner designed to protect Lake Burley Griffin and Foreshore's visual and symbolic role'*.

The *Lake Burley Griffin Water Quality Management Plan* sets out the current objectives and strategies for managing water quality.[220] The management objective is to protect the lake as an important visual, recreational and environmental feature of the National Capital for current and future generations.

Objectives include:

- Promoting the ornamental and visual values of the lake as intended by the National Capital Plan.
- Maintaining the lake as a viable and stable ecosystem, which encourages the development of plant and animal species in order to protect the ecological, aesthetic and scientific values of the lake and its foreshores.
- Having an acceptable quality-of-flow regime that enables the lake to be utilised as a water quality control pond to maintain, as far as practicable, downstream water quality and flow.
- Maintaining acceptable water quality to support the recreational and commercial functions of the lake.

219. National Capital Authority, 2016. *National Capital Plan*. National Capital Authority, Canberra.
220. National Capital Authority, 2011. *Lake Burley Griffin Water Quality Management Plan 2011*. National Capital Authority, Canberra.

The plan also incorporates national and local water quality guidelines to establish benchmarks for water quality parameters and recommend actions required to achieve those benchmarks.

### 10.5.2 Lake Tuggeranong

The ACT Government is responsible for the management of Lake Tuggeranong, the foreshore areas and the surrounding catchments. The approach to managing the lake is documented in the *Canberra Urban Lakes and Ponds Land Management Plan.*[221] The plan identifies the recreational, cultural and management values associated with Lake Tuggeranong. The main values include the maintenance of water quality to:

- facilitate public use of the lake and foreshore for recreation, including primary contact activities such a swimming
- support ecological function including water quality and aquatic plant and animal populations, and
- prevent and control pollution, protecting downstream waterways.

There is much concern over the ongoing water quality issues that continue to impact on Lake Tuggeranong. This concern was reflected in the funding provided under the 2014 Healthy Waterways Program. Lake Tuggeranong was allocated some $30 million to improve the water quality – this was around one-third of the program's total budget. The funding was used to establish water sensitive urban design measures to reduce pollutants entering the lake.

### 10.5.3 Lake Ginninderra

The ACT Government is responsible for the management of Lake Ginninderra, the foreshore areas and the surrounding catchments. The approach to managing the lake is documented in the Canberra Urban Lakes and Ponds Land Management Plan.  The plan identifies the recreational, cultural and management values associated with Lake Ginninderra. The main values include the maintenance of water quality to:

- facilitate public use of the lake and foreshore for recreation, including primary contact activities such a swimming
- support ecological function including water quality and aquatic plant and animal populations, and
- prevent and control pollution, protecting downstream waterways.

221. Environment, Planning and Sustainable Development Directorate, 2022. *Canberra Urban Lakes and Ponds Land Management Plan*. ACT Government, Canberra.
222. Ibid.
223. Environment, Planning and Sustainable Development Directorate, 2019. *Nature Conservation (Molonglo River Reserve) Reserve Management Plan*. ACT Government, Canberra.

### 10.5.4 Molonglo River

Within the ACT, the Molonglo River is managed by the ACT Government, with the National Capital Authority responsible for managing Lake Burley Griffin and some of its foreshores (see section **10.5.1** above). There is a specific plan of management for the Molonglo River downstream of Scrivener Dam – the *Molonglo River Reserve Management Plan*.[223] This plan identifies the Molonglo River Reserve as a *'substantial natural centrepiece running through the Molonglo Valley suburbs'*, and the river and its riparian areas are noted as providing important habitat for aquatic species as well as a number of important plants and animals. While the scope of the plan of management is quite broad, it identifies some key objectives such as protecting the naturalness of the reserve and improving the ecological condition of the river and riparian zones. Achieving these objectives relies on protecting the quality of water and the ecological character of the river and its riparian areas.

The Molonglo River is currently considered to be a non-urban system in the ACT Government's waterway management strategies. With the increasing expansion of urban development in the lower reaches (e.g. Whitlam, Coombs, Denman Prospect etc), the river should be classified and managed as an urban waterway downstream of Lake Burley Griffin.

### 10.5.5 Urban waterways

Although the ACT Government is responsible for managing urban waterways, there is currently no dedicated strategy or legislation for such waters.[224] This means that unlike Canberra's urban lakes and ponds, there is a lack of planning and guidance that informs the management of urban waterways. For example, the ACT Aquatic and Riparian Conservation Strategy which generally deals with the rivers and streams of the ACT, does not cover urban waterways.[225] The ACT Government should develop appropriate management policies for urban waters to address this management gap.

In the absence of dedicated guidance, urban waterways are currently managed under the broader remit of the *ACT Water Strategy 2014–44* outcomes which suggest requirements for the quality of water and aquatic ecosystems within Canberra's urban creeks and rivers.[226]

The water strategy stipulates that the ACT community should be provided access to healthy catchments and waterways to undertake water-based or water-dependent recreational activities without concerns for their health. This also means that riparian and aquatic ecosystems are provided with safe, clean water, that allows these ecosystems and associated biodiversity to be healthy and resilient. Outcomes from the strategy that are relevant to this Investigation include:[227]

Outcome 1: Healthy catchments and waterbodies

- Achieve integrated catchment management across the ACT and region.
- Protect and restore aquatic ecosystems in urban and non-urban areas.

224. This excludes the Molonglo River which is not currently considered to be an urban waterway in the ACT.
225. Environment, Planning and Sustainable Development Directorate, 2018. *ACT Aquatic and Riparian Conservation Strategy and Action Plans*. ACT Government, Canberra.
226. Environment and Planning Directorate, 2014. *ACT Water Strategy 2014–44: Striking the balance*. ACT Government, Canberra.
227. Ibid.

Outcome 3: A community that values and enjoys clean, healthy catchments and waterways

- Provide clean and safe water for the ACT.
- Engage the community on understanding and contributing to a more sustainable city.

### 10.5.6 Urban ponds and wetlands

The *Canberra Urban Lakes and Ponds Land Management Plan* presents the framework for the management of urban ponds and wetlands, including management objectives and strategies, as well as highlighting performance indicators and measures.[228] The main management objectives include:

- prevent and control floods by providing a reservoir to receive flows from rivers, creeks and urban run-off
- prevent and control pollution of waterways
- provide for public use of the lake or pond for recreation, and
- provide habitat for fauna and flora.

228. Environment, Planning and Sustainable Development Directorate, 2022. *Canberra Urban Lakes and Ponds Land Management Plan*. ACT Government, Canberra.

*Point Hutt Pond. Source: Fiona Dyer*

# 11

# Effectiveness of ACT Government urban water management

*Blue-green algae bloom in Lake Tuggeranong. Source: Alica Tschierschke*

## Contents

## 11.1 Summary of policies, plans and strategies relating to urban water management

Management of water within the ACT's urban areas is underpinned by several pieces of legislation which cover land use planning, infrastructure, water quality, and conservation. The principle Acts relating to urban water are the *Planning and Development Act 2007* and the *Environment Protection Act 1997*. The *Nature Conservation Act 2014* and the *Water Resources Act 2007* also contain elements which are relevant to urban water. Under these Acts, a suite of policies, plans and strategies deal with specific aspects of urban water management and protection. Key documents are described in Table 11.1 below.

### Table 11.1: ACT Government policies, plans and strategies relating to urban water management

*Note:* **statutory** *means that the document has a basis in legislation and is required by law.*

| Policy, plan or strategy | Purpose |
|---|---|
| Planning, development and construction | |
| The *Territory Plan* 2008 (EPSDD)<br>**Statutory** | The *Territory Plan* falls under the *Planning and Development Act 2007.* Its object is to ensure, in a manner consistent with the National Capital Plan, that planning and development in the ACT is done in a way which provides people with an attractive, safe and efficient environment in which to live, work and have their recreation. It includes codes for a variety of land and planning topics, which detail requirements in relation to those specific topics (see examples below). |
| Water Use and Catchment General Code 2009 (EPSDD)<br>**Statutory** | The purpose of this code (part of the *Territory Plan*) is to identify the ACT's permitted water uses and environmental values, as well as the water quality and streamflow criteria related to the full protection of these uses and values. |
| Waterways Water Sensitive Urban Design General Code 2020 (EPSDD)<br>**Statutory** | This code (part of the *Territory Plan*) makes provisions for the implementation of WSUD in all development and redevelopment sites. It stipulates the outcomes sought in relation to WSUD primarily through a series of targets for mains water use reduction, water quality and stormwater quantity, as well as permeability requirements and endorsement of an operation and maintenance plan for WSUD infrastructure (such as a pond or wetland on public land) that will be handed over to ACT Government for management after construction is complete.<br>The *ACT Practice Guidelines for Water Sensitive Urban Design* have been developed to support developers, the ACT Government and residents in complying with the WSUD General Code. |

| Policy, plan or strategy | Purpose |
|---|---|
| ACT Planning Strategy 2019 (EPSDD)<br>**Non-statutory** | This strategy guides long-term land-use planning in the ACT, setting out the intent for future areas to be developed. The themes for its development vision for Canberra are: compact and efficient, diverse, sustainable and resilient, liveable and accessible. Its implementation is closely tied to the Territory Plan. |
| Canberra's Living Infrastructure Plan: Cooling the City 2019 (EPSDD)<br>**Non-statutory** | This plan identifies challenges from climate change, urban growth and renewal, and the aging of the urban forest. The plan provides a response to address these challenges and to enhance Canberra's urban environment. |
| Canberra Urban Lakes and Ponds: Land Management Plan 2022 (EPSDD)<br>**Statutory** | This plan documents the values and uses, management objectives, management zones and services to be provided by entities for the major lakes and ponds, as well as neighbourhood ponds. The requirements for management plans for public land are set out in the Planning and Development Act 2007. |
| Stormwater: Municipal Infrastructure Standards 08 (TCCS)<br>**Non-statutory** | These design standards set out the requirements for how stormwater drainage systems must be designed in order to meet a number of objectives and principles to ensure a safe and sustainable urban environment. |
| Municipal Infrastructure Technical Specifications 16 Stormwater (TCCS)<br>**Non-statutory** | This documents provides detailed ACT-specific technical construction guidance for stormwater infrastructure, and include specific modules on bioretention systems, ponds, wetlands, and gross pollutant traps. |

| Policy, plan or strategy | Purpose |
| --- | --- |
| **Conservation** | |
| ACT Nature Conservation Strategy 2013–23<br>**Statutory** | This strategy is a document for all land management, planning, business, and community sectors in the ACT to guide a coordinated and integrated approach to nature conservation. The strategy aims to guide future management of the Territory's open spaces, rural areas, urban areas, riverine corridors and nature reserves, and guide investment of funding and resources. The requirements for this strategy are set out in the *Nature Conservation Act 2014*. |
| ACT Aquatic and Riparian Conservation Strategy and Action Plans 2018<br>**Statutory** | This strategy provides guidance on the conservation of aquatic and riparian areas in the ACT. This includes managing threats, maintaining and improving ecological connectivity, ecosystem function and biodiversity, undertaking monitoring and research programs, and partnering with the community to support aquatic and riparian conservation. The requirements for action plans for species and habitats are set out in the *Nature Conservation Act 2014*. |
| Molonglo River Reserve Management Plan 2019<br>**Statutory** | This plan sets out how the Molonglo River Reserve in the ACT is managed and restored over time to protect flora and fauna, provide recreational opportunities and minimise the risk of bushfire. It gives clear guidance on how the land and waters of the reserve will be managed and used. The requirements for reserve management plans are set out in the *Nature Conservation Act 2014*. |
| Murrumbidgee River Corridor Reserve Management Plan 1998<br>**Statutory** | This plan sets out how the Molonglo River Reserve in the ACT will be managed and restored. It is under review at the time of writing. The requirements for reserve management plans are set out in the *Nature Conservation Act 2014*. |
| Jerrabomberra Wetlands Nature Reserve Management Plan 2010<br>**Statutory** | This plan sets out how the Jerrabomberra Wetlands, which is an important site for migrating birds, is managed and protected. It gives clear guidance on how the land and waters of the reserve will be managed and used. The requirements for reserve management plans are set out in the *Nature Conservation Act 2014*. |

| Policy, plan or strategy | Purpose |
|---|---|
| **Environmental protection** | |
| Environment Protection (Water Quality) Environment Protection Policy 2012 (No 1)<br>**Statutory** | This policy aims to maintain, and where appropriate enhance, the ACT's water quality (as measured by standards prescribed by regulation or, when not available, other appropriate standards) by minimising or eliminating water pollution. |
| Environment Protection Regulation 2005<br>**Statutory** | This regulation is made under the *Environment Protection Act 1997* and details offences relating to the pollution of waterways, lists substances which are considered to be pollutants, and sets acceptable levels of pollution in water bodies used for different purposes (e.g., water-based recreation, aquatic habitat). |
| Environment Protection Guidelines for Land Development and Construction in the ACT<br>**Non-statutory** | This document provides detailed guidance on how environmental protection should be achieved during development and construction. A comprehensive review of the guidelines, by an independent consultant and with stakeholder consultation, was conducted in 2021 with the updated guidelines expected to be published soon. |
| **Flow** | |
| Water Resources Environmental Flow Guidelines 2019 (No 2)<br>**Statutory** | The Environmental Flow Guidelines are a legislative instrument under the *Water Resources Act 2007* that set out the flow requirements (quantity and timing) needed to maintain freshwater ecosystems. |
| Water Resources (Water Available from Areas) Determination 2019 (No 2)<br>**Statutory** | This legislative instrument sets out how much water can be extracted from the ACT's waters, both on the surface and below ground. The net take limits are 42.7GL per year for surface water and 3.16GL per year for ground water. |
| ACT Water Resource Plan for Surface and Groundwater (2020)<br>**Statutory (Cwth)** | This plan is an Australian Government policy document established under the *Water Act 2007* (Cwth). It sets out the water management arrangements for both surface water and groundwater resources in the ACT to in order to achieve of the objectives and outcomes of the *Murray-Darling Basin Plan 2012*. |

| Policy, plan or strategy | Purpose |
|---|---|
| **General water management** | |
| ACT Water Strategy 2014–44: Striking the Balance<br>**Non-statutory** | This strategy provides long term guidance to manage the Territory's water resources. It is intended to guide the development, integration and implementation of activities undertaken by government agencies (Commonwealth, State and Territory agencies), developers, the ACT community, natural resource management groups, and other stakeholders involved in planning and water management and water use, such as Icon Water.<br>The 30-year water quality target for the ACT laid out in this strategy is that it will maintain or improve the quality of water across all ACT managed sub-catchments. This includes ACT-managed urban catchments entering the Murrumbidgee River. Flow targets are also outlined for urban creeks, and natural and modified ecosystems. Modified ecosystems are those that have been modified by catchment activities and changes to flow regime, and include the Murrumbidgee River, Molonglo River and Lake Burley Griffin. Implementation plans have been developed to provide a more detailed road map for addressing key actions in the Strategy. |
| ACT and Region Catchment Strategy 2016–46<br>**Non-statutory** | This multi-jurisdictional strategy aims to provide a vision to all agencies, organisations and individuals involved in catchment management in the broader ACT region, incorporating most of the Murrumbidgee River catchment upstream of Burrinjuck Dam. It is focused on improving high level governance and cross-jurisdictional relationships through the activities of the ACT and Region Catchment Management Coordination Group. This strategy does not contain specific biophysical and social catchment targets but recognises that these need to be developed. Some of its actions seek to provide an integrated catchment planning approach for growth and settlement patterns in the ACT and Region, and for educating the community on catchment health. |
| Lake Burley Griffin Action Plan 2011: A Healthier, Better Functioning Lake by 2030<br>**Non-statutory** | This multi-jurisdictional plan proposes a coordinated program of actions in and around Lake Burley Griffin as well as in the ACT and adjoining NSW catchments. These actions are designed to address the health of the lake in the context of continuing urban growth and climate variability, to achieve measurable improvements. |

As shown in Table 11.1, the ACT Government has many plans and strategies in place which cover various aspects of urban water management. However, responsibility for these falls across a range of agencies responsible for various aspects of urban water quality and condition, and these appear to lack an overarching holistic approach to water quality and urban waterway management. As a result, ACT Government policies and strategies are not considered effective for supporting integrated catchment planning and management across existing and potential future urban catchments. An overall policy framework focused on urban catchment management could support improved integrated catchment management. Many of the strategy documents listed above outline high level policy objectives, but the demonstration of achievement through target setting, audit and systematic review of achievement of objectives is patchy.

To address the pressures on urban lakes and waterways, catchment management and planning is required at an urban catchment scale and on a more practical level. The next section reviews the efficacy of the current policies and practices in relation to all the areas which will need to be considered in the development of an overarching urban catchment strategy and supporting policy framework.

## 11.2 Effectiveness of urban catchment management

One of the foundational actions of the *ACT Water Strategy 2014–44* is to establish catchment management arrangements to better integrate water and land management for improved water quality and catchment health in the ACT and region. While this strategy does include actions around integrated catchment management, these generally relate to the high-level coordination of water matters at a regional scale. There is currently no overall strategic catchment management strategy, plan or policy for agencies to operate against.

It was acknowledged in the *Water Sensitive Urban Design Review*[229] by both EPSDD and TCCS that they had not undertaken catchment-wide planning for stormwater in the ACT. This is despite stormwater being one of the key pressures on the health of urban lakes and waterways in the ACT. The need for strategic decision making to address current and future challenges to the lakes was recognised in the 2012 Report *on the State of Watercourses and Catchments for Lake Burley Griffin* by this Office, and remains just as relevant today (see **Chapter 1, section 1.1**).

The *Canberra Urban Lakes and Ponds Land Management Plan* describes the management objectives of Canberra's urban lakes and ponds. These are to:

1. Prevent and control floods by providing a reservoir to receive flows from rivers, creeks and urban run-off.
2. Prevent and control pollution of waterways.
3. Provide for public use of the lake or pond for recreation.
4. Provide habitat for fauna and flora.

229. Environment and Planning Directorate, 2014. Water Sensitive Urban Design Review. ACT Government, Canberra.

However, these objectives are not necessarily aligned or complementary, and all of these objectives are applied to all urban lakes and ponds in the ACT, so the primary objective of each individual waterbody is unclear.

To complicate matters further, in accordance with section 317 of the *Planning and Development Act 2007*, if there is an inconsistency between the application of two management objectives, the objective appearing later in the schedule is to be read subject to the earlier objective, thus creating a hierarchy of management objectives. As such, a lake may be managed to control floods and mitigate the pollution of downstream waterways ahead of any public use or ecological objectives. Problems with community expectations and satisfaction are exacerbated if the primary objective(s) of each waterbody is not clearly stated and understood.

The *Canberra Urban Lakes and Ponds Land Management Plan* also outlines responsibilities of a range of ACT Government agencies for managing different aspects of the lakes and ponds. However, it does not present a strategic plan by the different agencies to address current and future challenges to water quality, aquatic and riparian health, and amenity. It also does not consider the lakes within the context of their catchments but rather as standalone assets.

The *Waterways: Water Use and Catchment General Code* is the policy which is intended to identify permitted water uses and environmental values in the waters of the ACT, and to articulate the water quality and streamflow criteria for protection of these uses and values. Currently, there is a gap in this code in capturing the environmental and community values of urban lakes, ponds and waterways and associated requirements for water quality and flows. This code also has poor linkage with the closely-related *Waterways: Water Sensitive Urban Design Code.* There is an opportunity to review the *Waterways: Water Use and Catchment General Code* to address these shortcomings.

*As previously noted, management responsibilities are shared across multiple agencies, and in the case of urban catchment management responsibility for policy development is often different from those which are responsible for implementation of those policies. This separation of responsibilities becomes a barrier to effective resource management when there are not mechanisms for effective coordination and planning that guides integrated management.*

## 11.3 Effectiveness of aquatic and riparian ecosystems policy

Riparian ecosystems occur in land areas located alongside watercourses and waterbodies. They have specialised soil and vegetation traits due to the presence of water. Both aquatic and riparian ecosystems are important habitat for wildlife, and the vegetation associated with them are essential for ground stabilisation. A key feature of urban waterways in the ACT is the engineered nature of the system which has virtually eliminated most natural riparian ecosystems and their associated habitat values. In general, the physical form of urban waterways in the ACT tend to transition from highly modified concrete channels in highly urbanised areas, to concrete swales with grassy banks in mid-reaches, to more "natural" but disturbed sections in upper reaches.

The *ACT Aquatic and Riparian Conservation Strategy and its associated Action Plans*[230] provides guidance on the conservation of aquatic and riparian areas and component species in the ACT. However, urban lakes, ponds and waterways are not specifically covered in this strategy. Whilst it covers the Molonglo and Murrumbidgee Rivers, it does not cover wetlands nor urban waterways such as the Queanbeyan River, or Tuggeranong, Weston, Yarralumla, Sullivans, Woolshed, Jerrabomberra and Ginninderra creeks. Riparian zones surrounding artificial lakes, large floodplain areas or substantially modified urban water courses are also excluded.

The *ACT Aquatic and Riparian Conservation Strategy and Action Plans* recognises the many environmental pressures caused by urbanisation, such as reduced water quality, modified flows, creation of barriers to fish and other wildlife, increased pest animals and weed invasion, increased fishing pressure, loss of habitat structure, and modification of riparian zones to meet recreational and urban expectations.

In terms of both urban and non-urban waterways, the strategy provides high-level guidance on managing a range of interacting threats. However, there is no defined approach for protecting and enhancing the aquatic and riparian health of urban waterways and lakes at a city-scale. This is a clear gap in the strategy because these urban parts of the catchment are the main source many of the threats and impacts on downstream waterways with higher ecological values. Urban waterways could also offer habitat corridors for wildlife to move through Canberra's urban areas more easily and safely.

Land development is already having a direct and substantial impact on the aquatic and riparian health of the Molonglo and Murrumbidgee Rivers. This is largely a result of poor erosion and sediment control practices during construction, and limited guidance (and lack of application of existing guidance) on design of stormwater management at the urban edge. Urban edge development is a specific area of concern, as **receiving waters**[231] adjacent to these developments are likely to be more ecologically sensitive than those within urban areas.

230. Environment, Planning and Sustainable Development Directorate 2018. ACT Aquatic and Riparian Conservation Strategy and Action Plans. ACT Government, Canberra.
231. Receiving water is a body of water – such as a pond, river, lake, ocean, or any watercourse – into which wastewater or treated water is discharged.

The *ACT Aquatic and Riparian Conservation Strategy* does provide some guidance on managing some of the threats that occur in urban edge developments areas but this is not being adequately applied in practice. Sediment from construction also negatively affects stormwater infrastructure such as ponds, GPTs and channels.

## 11.4 Effectiveness of water quality policy

The *ACT Water Strategy 2014–44* provides a target to maintain or improve water quality across all ACT-managed catchments. The indicator related to this target is:

> **AUSRIVAS**[232] performance classifications for select reaches of major rivers are maintained or improved. The level of nutrients, organic material and sediment loads entering the ACT reach of the Murrumbidgee River is no greater than from a well-managed rural catchment.

The strategy also has an interim target for a measurable improvement in catchment health in areas that received funding for on-ground works from the Australian Government-funded ACT Basin Priority Project (i.e. the Healthy Waterways Program). The indicators for this target cover phosphorus, organic matter and suspended solids. However, the strategy does not state what the baseline levels of these pollutants are and how improvements against them will be measured. Refer to section **11.8** for further discussion about the limitations of water quality monitoring in the ACT.

Existing information about indicators, targets, and threshold values is distributed across multiple documents and managed by different agencies. This leads to a lack of clarity around the specific targets and thresholds that are in place and increases the risk that inconsistencies will arise. T*he Canberra Urban Lakes and Ponds Land Management Plan* notably has slightly different thresholds to those from the *ACT Guidelines for Recreational Water Quality, the Environment Protection Regulation 2005 values for urban lakes and ponds (AQUA/3),* and the *Environment Protection Regulation 2005 values for urban wetlands (AQUA/5)*[233]. While it is important that indicators, targets and thresholds are regularly reviewed, it would be beneficial to establish a clear central point of documentation to guide management and ensure consistency.

*Holder wetlands. Source: Miranda Gardner*

232. The Australian River Assessment System, developed by eWater with Australian Government funding as a way to consistently measure the biological health of rivers in Australia https://ausrivas.ewater.org.au/index.php/introductionmainmenu
233. Environment, Planning and Sustainable Development Directorate, 2022. *Canberra Urban Lakes and Ponds Land Management Plan.* ACT Government, Canberra.

## Key actions for water quality policy

That the ACT Government:

**Key Action 11.1**: Establish consistent management indicators, targets and threshold values for urban waters.

**Key Action 11.2**: Establish nitrogen standards and threshold values for recreational waters and the protection of aquatic ecosystems in the ACT's urban waters.

**Key Action 11.3**: Undertake a systematic review of the current guidance on nitrogen to phosphorus ratios used by ACT water managers to limit algal growth. The review should also extend to the impacts of high nitrogen levels on aquatic ecosystem health.

**Key Action 11.4**: Undertake a systematic review of the current guidance on phosphorus concentrations used by ACT water managers to limit algal growth for all urban waters.

**Key Action 11.5**: Establish clear and consistent ecological condition standards, targets and indicators for urban waters to enable assessment of ecosystem health and management effectiveness. This should include all ponds, lakes, creeks and other running waters.

**Key Action 11.6**: Implement outstanding projects from the *Water Sensitive Urban Design Review 2014.*

**Key Action 11.7**: Strengthen the *Environmental Protection Guidelines for Construction and Land Development* to include more information on how erosion and sediment control should be staged.

### 11.4.1 Threshold values – nitrogen

The ACT does not specify total nitrogen standards or threshold values for recreational waters or the protection of aquatic ecosystems. Standards are only established for nitrate and nitrite in drinking water to protect public health.

For recreational waters and aquatic ecosystems in urban lakes and ponds, a nitrogen to phosphorus ratio of greater than 12:1 is recommended in the *Environment Protection Regulation 2005 values for urban lakes and ponds*[234]. This ratio has been taken by some urban water managers to mean that an unlimited nitrogen concentration is acceptable with regard to algal bloom prevention, although such a conclusion is unlikely to have been the intent of the original regulation. The 2012 Investigation of Lake Burley Griffin also stated that *'the potential threat from nutrients in forming algae growth is ameliorated in the effluent discharged due to its low phosphorus and high nitrate concentrations'*.[235]

234. Environment Protection Authority, 2005. *Environmental Protection Regulations*. ACT Government, Canberra.
235. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.

The 12:1 nitrogen to phosphorus ratio is based on the past theory that nitrogen is not a limiting nutrient for algal growth. This view arose from studies that have shown nitrogen to phosphorus ratios are key determinants of algal populations.[236,237] While such studies have always suggested high variability for the nutrient limitation of algal growth in freshwaters, the belief that high nitrogen levels reduce the risk of algal blooms has found its way into the ACT's urban water management.

The continued acceptance of the 12:1 nitrogen to phosphorus ratio is no longer supported by most involved in the management of algal blooms and represents a risky approach for the management of urban lakes and ponds.[238, 239, 240, 241, 242, 243]

There has not been a systematic review of the literature to provide widely accepted guidance to water managers on nitrogen to phosphorus ratios and algal growth. Recent research continues to suggest that there is substantial variability in the nutrient thresholds for cyanobacterial growth in lakes and that the response of cyanobacteria to a range of conditions is complex. For example, it has been demonstrated that high nitrogen to phosphorus ratios can enhance the processes of phosphate uptake by cyanobacteria rather than favouring other algal species.[244]

It is recommended that the specified standard for a 12:1 nitrogen to phosphorus ratio is revisited to determine the relevance to Canberra's urban lakes and ponds and that updated threshold values for nitrogen are established. The Australian and New Zealand Environment and Conservation Council water quality guidelines offer default threshold values for nitrogen for the protection of freshwater ecosystems and these would seem to be a good starting point for the establishment of standards.

### 11.4.2 Threshold values – phosphorus

The current acceptable ranges of total phosphorus concentrations in Canberra's urban lakes (< 0.06 milligrams per litre for Lake Burley Griffin and ≤0.1 milligrams per litre for other lakes and ponds) lack biological relevance to the lake processes that cause algal blooms. Phosphorus is recognised as the limiting nutrient for cyanobacterial blooms in lake systems and there is some thought that concentrations below 0.025 milligrams per litre are limiting to cyanobacterial blooms.[245]

236. Biggs, B. J., 2000. *Eutrophication of streams and rivers: dissolved nutrient-chlorophyll relationships for benthic algae*. Journal of the North American Benthological Society 19(1):17–31.
237. Guildford, S. J., and Hecky, R. E., 2000. *Total nitrogen, total phosphorus and nutrient limitation in lakes and oceans: Is there a common relationship?* Limnology and Oceanography 45(6):1213–1223.
238. Chorus, I., and Spijkerman, E., 2021. *What Colin Reynolds could tell us about nutrient limitation, N:P ratios and eutrophication control*. Hydrobiologia 848(1):95–111.
239. Dolman, A. M., et al., 2012. *Cyanobacteria and Cyanotoxins: The Influence of Nitrogen versus Phosphorus*. PLOS ONE 7(6):e38757.
240. Dolman, A. M., and Wiedner, C., 2015. *Predicting phytoplankton biomass and estimating critical N:P ratios with piecewise models that conform to Liebig's law of the minimum*. Freshwater Biology 60(4):686–697.
241. Hamilton, D., Salmaso, N., and Paerl, H., 2016, *Mitigating harmful cyanobacterial blooms: strategies for control of nitrogen and phosphorus loads*. Aquatic Ecology 50:1–16.
242. Harris, T. D., et al., 2014. *Experimental manipulation of TN:TP ratios suppress cyanobacterial biovolume and microcystin concentration in large-scale in situ mesocosms*. Lake and Reservoir Management 30(1):72–83.
243. Maberly, S. C., et al., 2020. *Nitrogen and phosphorus limitation and the management of small productive lakes*. Inland Waters 10(2):159–172.
244. Aubriot, L., and Bonilla, S., 2018. *Regulation of phosphate uptake reveals cyanobacterial bloom resilience to shifting N:P ratios*. Freshwater Biology 63(3):318–329.
245. Dolman, A. M., et al., 2012. *Cyanobacteria and Cyanotoxins: The Influence of Nitrogen versus Phosphorus*. PLOS ONE 7(6):e38757.

Similar to nitrogen to phosphorus ratios, it would be beneficial to undertake a systematic review of the literature to determine the appropriate total phosphorous concentrations for limiting cyanobacterial blooms in urban lakes. This could then be used to develop more relevant phosphorus targets for the ACT's urban lakes. Assessments of current phosphorus targets should be undertaken in conjunction with targets applied to lake inflows as part of a broader strategy to reduce the incidence of cyanobacterial blooms.

### 11.4.3 Guidance for ecological condition in urban waters

There is little specific guidance about the expected ecological condition or the targeted ecological condition for most urban waterways. The *Environment Protection Regulation (2005)* establishes water quality targets and environmental standards for different types of waterbodies within the ACT. This includes recreational and aesthetic values of waterways and in some instances incorporates ecosystem indicators. However, while standards for water quality parameters (e.g., phosphorus concentrations) and some ecosystem attributes (e.g., cyanobacterial cell counts) are clearly numerically defined and easy to apply, other are far less clear. For example, the standards specified for aquatic macrophytes (both floating and rooted macrophytes) and water colour are that they are *'not objectionable'*. This is clearly inadequate given how '*not objectionable*' might be determined is an open to individual interpretation.

The *Canberra Urban Lakes and Ponds Land Management Plan* provides targets for some indicators of ecological condition for a range of zones within urban lakes and ponds, but similar targets and indicators are not available for urban creeks, rivers and other waterways.[246] This makes it difficult to evaluate the extent to which the urban waterways are performing in relation to their desired environmental state. It would be valuable to establish a set of indicators of ecological condition for all types of urban waterways to guide management activities.

Stormwater quality targets in the *Waterways: WSUD General Code* are not tied to environmental outcomes in receiving waters, and as they currently stand may not be sufficient to avoid an increase in pollutant loads from greenfield developments entering urban lakes and ponds. There is no urban-scale catchment strategy that outlines how 'development targets' and 'regional targets' for stormwater treatment specified in the *Waterways: WSUD General Code* will be applied in practice to improve conditions in urban lakes and waterways and to meet ecological objectives for the Murrumbidgee River.

Assessment[247] of future development opportunities and constraints in the **Western Edge Investigation Area**[248] showed that if the mandated 'development targets' for stormwater treatment in the *Waterways: WSUD General Code* are applied at a site changing from a 'well-managed rural catchment' to a predominantly urban catchment, there would be an increase in pollutant loads leaving the site compared to pre-developed condition. This is based on technical modelling undertaken for the assessment, using assumptions on pollutant load generation in urban and rural catchments. The modelled export loads from the site also would not meet *ACT Water Strategy* interim targets for urban catchments for total phosphorus and total suspended solids.

246. Environment, Planning and Sustainable Development Directorate, 2022. Canberra Urban Lakes and Ponds Land Management Plan. ACT Government, Canberra.
247. Alluvium 2020. Western Edge Investigation Area – Water Values and Environmental Hydrology Assessment, Technical report prepared for the ACT Government (EPSDD), Canberra.
248. An area to the west of Canberra's current urban footprint identified in the ACT Planning Strategy for potential future development.

The implication of this is that there will be an increase in pollutant loads entering receiving waters, including the Murrumbidgee River, if regional projects for stormwater treatment are not undertaken in addition to development site projects. Interim targets can be met if 'regional targets' under the Waterways WSUD code are applied. However, even when regional targets are applied, there remains an increase in loads compared to pre-developed condition (i.e., a well-managed rural catchment).

This highlights the importance of developing an urban catchment strategy that outlines how the 'development' and 'regional' targets will be applied in practice to meet objectives for urban lakes, ponds and waterways and, ultimately, the Murrumbidgee River. To mitigate against untreated stormwater entering receiving waters, rigorous quality treatment should be mandated in all catchments within which urban development is planned.

Current policy under the *Waterways: WSUD General Code* also requires that stormwater detention measures are provided in new residential developments and that the peak rate of stormwater runoff from the estate does not exceed the peak rate of runoff from a rural site of the same. The code does not fully consider the potential for erosion under different flow scenarios.

The *Environmental Protection Guidelines for Construction and Land Development* provide guidance on preferred methods for pollution control design, construction operation and maintenance during construction, and land development activities to protect the environment. In terms of erosion and sediment control, the guidelines provide principles of pollution control, and measures appropriate for commonly experienced situations in the ACT. The guidelines provide a comprehensive list of approaches for surface water management and sediment control. The guidelines are also referenced in all development codes. This investigation supports the recommendations in the *Water Sensitive Urban Design Review 2014* to strengthen the *Environmental Protection Guidelines for Construction and Land Development* with more information on how erosion and sediment control is staged.

This analysis indicates that the current *Waterways: WSUD General Code* is inadequate to maintain and improve water quality in the ACT, even when it is correctly adhered to.

*Litter at Point Hutt Pond. Source: Fiona Dyer*

## 11.5 Effectiveness of planning decision and development assessment policies and processes

This section considers the approval process with regards to WSUD infrastructure in developments. The evaluation covers the planning stage of the WSUD infrastructure life cycle which is key stage over the course of the development approval process. The evaluation of other stages of WSUD infrastructure (design, construction, establishment, and operations and maintenance stages) are covered in **section 11.6** below.

The findings are based largely on:

- The findings of the ACT Auditor-General's *Report on Acceptance of Stormwater Assets*[249] – an audit which found deficiencies in the **acceptance**[250] and management of stormwater assets by the ACT Government. All but one recommendation was agreed and incorporated into the actions of the ACT Water Strategy Implementation Plan Two.
- Review of the *ACT Practice Guidelines for Water Sensitive Urban Design*[251] which is intended to be used to assess development applications and outline the relevant requirements to intending applicants in designing development proposals and preparing development applications.
- Findings of an audit of WSUD assets in the ACT in 2015, which included interviews with relevant ACT Government staff, asset inspections and asset performance monitoring.

The *ACT Practice Guidelines for Water Sensitive Urban Design* is a supporting document to the *Waterways: WSUD General Code*. It helps to explain the planning provisions set out in the WSUD Code, and to provide guidance and options for compliance with the code. The guidelines are also intended to support both applications for and assessment of development applications. In the past, the quality of WSUD design and the level of service obtained from constructed assets have varied significantly, in part due to documentation and lack of transparency in the planning and design stage.

Module 2[252] of the guidelines includes steps to be undertaken during the planning stage, design stage, delivery stage and maintenance stage, and goes some way towards providing clarity for the requirements at each stage. At the planning stage, steps are outlined for developing a WSUD strategy with the intent that a WSUD outcome plan and stormwater masterplan is submitted to EPSDD for approval. The guidelines also require reporting against the objectives of the *Waterways: WSUD General Code*, including modelling of the predicted effectiveness of any WSUD measures to be put in place.

249. ACT Auditor-General, 2018. *Report on Acceptance of Stormwater Assets*. ACT Government, Canberra.
250. In this context, 'acceptance' describes the process where a private entity officially hands over a piece of infrastructure to the ACT Government. Stormwater infrastructure built as part of new developments becomes the responsibility of ACT Government once construction is complete.
251. Environment, Planning and Sustainable Development Directorate, 2017. *ACT Practice Guidelines for Water Sensitive Urban Design*. ACT Government, Canberra. The Practice Guidelines are published in two modules: Module 1: Introduction to WSUD in the ACT and Module 2: Designing Successful WSUD.
252. Environment, Planning and Sustainable Development Directorate, 2017. *ACT Practice Guidelines for Water Sensitive Urban Design, Module 2: Designing Successful WSUD*. ACT Government, Canberra.

The intent is for these documents to be scrutinised by the Development Assessment Team; in practice it appears that detailed scrutiny of the WSUD elements of development applications, including the technical modelling, rarely occurs. This is likely in part due to the fact that personnel with the relevant expertise for this work are distributed throughout EPSDD and not based within the Development Assessment Team. Assessment of development applications is not a core part of the role of these people, and requests for assistance with reviewing development applications compete with their other duties. This means that possible issues with WSUD proposals for developments may not be picked up early enough in the process, if at all.

During the development application process, EPSDD is the organisation that approves the application. There is a process for EPSDD to seek input from various entities such as TCSS including response to the proposed solutions in terms of maintenance. EPSDD does not need to refer the application to an entity if it is satisfied that the applicant has sufficiently consulted the entity (e.g., prior to the development application) or if the entity has agreed in writing to the proposed development (see finding 3.6 in the Auditor-General's report). However, finding 3.9 of the Auditor-General's report suggests wider consultation across TCCS would be desirable at the development application stage.

The 2015 WSUD Audit project identified several other issues with the broader process from development approval to handover of WSUD infrastructure:

- Stormwater quality outcomes can change significantly between development approval and asset acceptance, and this is not picked up in the current process.
- Poor concepts, designs and constructed outcomes can be approved at each stage of the process resulting in assets being in poor condition at handover to TCCS, making them difficult to maintain at the required standard (e.g., without vegetation being well enough established).
- Potential maintenance issues are not picked up until after handover is complete.

These issues sometimes result in WSUD infrastructure being handed over to TCCS in poor, even non-functional, condition. This adds to TCCS' challenges in maintaining accepted assets in working order. A number of reasons may explain why these issues arise:

- As mentioned above, it is possible that consultation during the development application and design review stages does not cover all the required entities, or expert teams and individuals within those entities, in the ACT Government. It is likely that a more rigorous stakeholder mapping and engagement process is needed for each stage of the WSUD asset lifecycle to assist with this.
- A lack of capacity hinders the ability of staff to undertake meaningful review during development application and design review stages.
- Input from maintenance staff is not always sought at the design review stage. When maintenance staff do provide comments at the design stage, they report that their concerns are not adequately addressed.

It is worth noting that both EPSDD and TCCS have documented the development application process and asset acceptance process and they are consistent (Finding 3.7 in the Auditor-General's report). The report outlines that the roles and responsibilities of agencies involved in the stormwater asset acceptance process are clearly articulated. EPSDD is responsible for approval of development applications. Following the development approval, TCCS is responsible for asset design approval and asset acceptance at handover. The *Water Sensitive Urban Design Review* report Priority Project 8 recommends the development of a guideline to inform the effective transfer of government-owned WSUD infrastructure from construction to management; if this has occurred, it is a step in the right direction. Consultation with all relevant stakeholders should take place as early in the process as possible.

However, the Auditor-General's report also notes that:

> *...an agency-focused negotiation process currently determines what design is to be used and consequently what asset is accepted. This needs to be replaced with a process that focuses on the ACT Government's stormwater objectives, so that optimal stormwater solutions are achieved. Not having this process carries the significant risk that accepted assets may not achieve the ACT Government's stormwater objectives, as articulated in legislation and policy.*[253]

The report goes on to state:

> *This is due to TCCS strong focus on adopting the least cost option for maintaining those assets and not necessarily the most appropriate stormwater management solution. In many cases, the optimal solution (achievement of stormwater objectives in a cost-effective manner) is likely to require higher operation and maintenance costs. This requires that different options for financing the operation and maintenance of the assets be considered at the design stage.*[254]

In short, the current process is driven by cost-saving with little consideration for stormwater management objectives and environmental outcomes. This issue is related to a lack of strategic approach on stormwater management in the ACT, and to limited resourcing for operations and maintenance of WSUD assets. Catchment-wide planning to inform stormwater management objectives and communication of these objectives to all agencies will help to address this issue. Explicit consideration of operations and maintenance (and financing) of proposed assets at the planning and design stage is also important.

### *Key action for planning and development*

The ACT Government should:

**Key Action 11.8:** Explicitly consider operations and maintenance of proposed assets at the planning and design stage, including how these will be financed.

253. ACT Auditor-General, 2018. Report on Acceptance of Stormwater Assets. ACT Government, Canberra. p2 & 41.
254. Ibid, p58.

## 11.6 Effectiveness of Water Sensitive Urban Design measures

In the ACT, WSUD infrastructure includes the vast majority of Canberra's urban lakes, ponds and wetlands. Refer to the Breakout Box in section **2.3** for an explanation of the water sensitive urban design (WSUD) approach. Various reviews and studies[255, 256, 257] of Canberra's water sensitive urban design infrastructure have revealed a range of areas where policy implementation and management could improve.

The Waterways: WSUD General Code specifies the requirements for WSUD measures to be implemented in both private developments and the public realm. This section will predominantly consider the effectiveness of WSUD in the public realm since this is directly within the control of the ACT Government. Issues arising from WSUD in the private realm are largely related to compliance, which is considered in **12.3 Compliance and enforcement of water protection measures.**

*The Water Sensitive Urban Design Review*[258] identified issues with the legislative framework and proposed eight priority projects to address the issues. One of these projects – revision of the Waterways: WSUD General Code and the development of supporting practice guidelines – has been completed. The remaining seven projects are still relevant and should be implemented by the ACT Government as soon as is practicable.

Notwithstanding the recent revisions to the *Waterways: WSUD General Code* and the development of practice guidelines, a few areas for additional improvements remain:

- For the green/living infrastructure element, the rule in the Waterways: WSUD General Code requires a minimum 20 per cent of the site to be permeable. This target is likely being achieved under business-as-usual practices. It does not align with the *ACT Living Infrastructure Plan* target of 30 per cent permeable surfaces in Canberra's urban footprint by 2045.
- The *Waterways: WSUD General Code* makes provision for a stormwater management offset scheme when the implementation of appropriate WSUD measures onsite are technically unfeasible or prohibitive in cost. However, it is acknowledged in the guidelines that the ACT Government does not currently have a stormwater management offset scheme.
- There is an action in the *ACT Water Strategy* to integrate water cycle management and green infrastructure into the planning and design of urban environments. It is important the *Waterways: WSUD General Code* and practice guidelines are updated over time to align with the recommendations from the *ACT Living Infrastructure Plan* and the 'holistic water cycle management plan' which is scheduled to be developed in 2020–21 as per *Implementation Plan Two of the ACT Water Strategy.*

255. Alluvium, 2016. *A Strategic Review and Analysis of Act Urban Water Quality Management Infrastructure. Final report by Alluvium Consulting Australia for the ACT Government, Environment and Planning Directorate.* Basin Priority Project, Canberra.
256. Ubrihien, R. F., et al., 2019. *Urban Ponds Research Project Final Report. A report to the ACT Government by the Institute for Applied Ecology*. University of Canberra, Canberra.
257. Abbott, S., et al., 2008. *Canberra's Urban Ponds – Ecological responses to variation in water level.* A report to the ACT Government by the Institute for Applied Ecology, Canberra.
258. Environment and Planning Directorate, 2014. *Water Sensitive Urban Design Review*. ACT Government, Canberra.

In general, there is a need to re-think stormwater treatment beyond simple pond systems in established urban areas. A higher standard of treatment is required to target finer and soluble pollutants – this could be achieved through constructed wetlands, bioretention systems and similar infrastructure. Water sensitive urban design (WSUD) measures in the ACT have historically been designed with a focus on removing sediments from stormwater. This is due to the assumption that most of the nutrients transported during storm events are in **particulate form**,[259] rather than in **dissolved form**.[260] However, recent research on Lake Tuggeranong has highlighted that a significant proportion of nutrients (up to 50%) are being transported in dissolved form through the stormwater network during high flows.[261] This has also been found to occur during storm events monitored in Sullivan's Creek.[262]

The management of nutrients in dissolved form has largely been overlooked in the ACT's current water quality protection measures. Consequently, WSUD approaches and modelling tools are based on trapping particulate nutrients and do not account for stormwater flows which may contain up to 50 per cent of total nutrients in dissolved form. This focus on particulate form nutrients may have significant implications for determining the effectiveness of urban runoff management. With such high levels of dissolved nutrients, WSUD measures are unlikely to be performing as intended in terms of trapping and removing nutrient pollution.

*As Canberra's urban area grows, so will the volume of urban runoff and the pollutants it contains. This means that improved management of dissolved nutrients needs to be implemented as soon as possible if we are to avoid long-term ramifications for water quality from decisions for new developments. This is particularly true for those developments in close proximity to the Molonglo and Murrumbidgee Rivers.*

*Confluence of Sullivan's creek and downtream of David St wetland. Source: Fiona Dyer*

259. Particulate form nutrients are phosphorus and nitrogen attached to particles in lakes and other waters.
260. Dissolved nutrients are soluble phosphorus and nitrogen in lakes and other waters.
261. Ubrihien, R., et al., 2019. *Lake Tuggeranong Research Project: Research findings and recommendations. A report to the ACT Government from the Institute for Applied Ecology at the University of Canberra*. Canberra.
262. Dyer, F., 2000. *Nutrients in Sullivan's Creek*. CSIRO Land and Water Technical Report, Volume 2/00, CSIRO Land and Water, Canberra.

### 11.6.1 Performance of WSUD assets in the public realm

This section considers the construction, establishment and operation of WSUD infrastructure in the public realm. These systems are generally built by developers working on large-scale developments, and are handed over to the ownership of the ACT Government for operation and maintenance once construction is complete. They are often used to contain sediment generated during construction, and then re-purposed as stormwater treatment ponds for the new urban catchment after construction is complete. This in itself can be problematic as the design requirements for sediment control ponds are not the same as those for urban stormwater retention ponds.

The *Canberra Urban Lakes and Ponds: Land Management Plan* describes how ACT lakes and ponds should be designed with three different 'zones' that progressively remove pollutants as stormwater moves through each of them. However, these zones have not been appropriately designed and constructed in many of Canberra's urban lakes and ponds, increasing the risk of poor water quality conditions and algal blooms.

The ACT Healthy Waterways program has afforded an opportunity for the ACT Government to deliver a range of industry best practice stormwater treatment systems. Learnings from the delivery of these projects and ongoing management of the assets should be used to provide specific ACT context to design guidance and standards updates in the future.

#### *Design phase*

A 2015 audit by independent consultants of the performance of stormwater treatment assets in the ACT found that many fundamental issues arose during the design stage, including:

- Lack of basic features which are standard practice for effective stormwater treatment systems, including high flow bypass, extended detention and adequate pre-treatment.
- Poor design of inlets and diversion systems, meaning that in many cases very little water is able to enter stormwater treatment systems.
- Inadequate consideration of maintenance requirements, leading to access issues for WSUD assets; many ponds and wetlands cannot be drained and bioretention systems lack flushing points.

*Development in Belconnen. Source: Ryan Colley*

Where consideration of maintenance requirements is inadequate, the cost to maintain assets after handover is increased and some infrastructure may even require modification to function effectively. The key reasons for these issues are as follows:

- Limited capacity in the local industry (there is some evidence this has improved in recent years).
- Limited scope of design standards and specifications. While the Stormwater: Municipal Infrastructure Standards 08 have gone some way towards closing the gap in standards available for WSUD assets, they are based largely on design manuals developed in other jurisdictions and may not always represent the best approach for the ACT.
- Selection of inappropriate plant species, which has led to vegetation establishment failure in some stormwater treatment systems.
- Poor integration between civil, landscape and ecological design aspects of the same project, with a lack of specialist expertise on stormwater treatment.
- Poor co-ordination between design teams working on separate but related projects. For example, at Coombs, regional stormwater ponds were designed and built before the design and construction of the subdivision. Flow paths, catchment areas and ground levels were altered during construction, meaning that some of the design assumptions on which the ponds were based were incorrect by the time the subdivision was completed.

### *Construction phase*

As noted above, staging of construction has been found to be a significant construction-related issue in new developments. WSUD infrastructure is often constructed and established relatively early in the construction phase while there are still significant amounts of sediment moving off construction sites into drainage lines and creeks. While ponds are generally suitable for capturing construction sediment, there is a significant difference between a sediment pond designed as a short-term installation to capture a large sediment load, and a pond or wetland designed for long-term water quality management. Vegetated stormwater treatment systems such as wetlands, bioretention systems and swales are not designed to capture construction sediment and are easily over-loaded with sediment during the construction phase. This can cause significant damage which is not easily rectified. Gross pollutant traps can also be damaged by construction-stage sediment loads.

Damage to WSUD infrastructure is seen even when other erosion and sediment control measures, such as sediment fences and sandbags, are used during construction. However, evidence collected for this report suggests that these types of erosion and sediment controls are often poorly implemented during construction (refer to **Chapter 12 Urban Development and the ACT's lakes and waterways** for further discussion on this).

It is noted that a number of options are now provided in the *ACT Practice Guidelines for Water Sensitive Urban Design* to prevent damage to WSUD assets from sediment during construction. Studies to ascertain whether the release of the guidelines has resulted in improved practices in this area would be beneficial in determining the efficacy of this policy approach.

### *Establishment phase*

Establishment describes the period where plants in a vegetated WSUD system grow to maturity and develop stable root systems. It is a key stage in the life cycle of a vegetated stormwater treatment system but it has a history of insufficient attention in the ACT. Wetland plants establish well in shallow water, and water level increases needs be managed during establishment so that part of the plant always remains above the water level. There have been a number of examples where wetland vegetation has drowned in deep water before it was sufficiently established.

The causes behind establishment issues are generally that:

- Plant establishment is a less critical issue for other types of public assets and therefore government systems are generally not set up to deal with a long establishment phase.
- Establishment of wetland vegetation in particular is a specialist skill which is not widely understood in the industry.
- Along with maintenance, establishment is given inadequate consideration at the design stage.
- Construction contracts do not typically include a meaningful allowance for plant establishment.
- The establishment phase is maintenance intensive and unless it is clearly identified as part of the implementation cost it may be difficult to resource.

Despite these challenges, effective establishment does pay off in the long run due to reduced maintenance costs over the life of an asset. It is noted that guidance on establishment is now included in the *ACT Practice Guidelines for Water Sensitive Urban Design*, but data have not been collected on whether this has resulted in improvements in establishment practices.

### *Operations and maintenance phase*

The *Waterways: WSUD General Code* requires provision of an operations and maintenance plan for all WSUD assets. However, the ACT Government appears under-resourced for operations and maintenance of WSUD assets, which means that these plans are not always implemented. WSUD systems that are not fully maintained may not function effectively and may not deliver the water quality improvements for which they were designed. Therefore, the benefit to the urban lakes, ponds and waterways is not realised over the long term.

In ACT ponds, lakes and wetlands, no routine maintenance is undertaken within the water body itself. Landscape maintenance is largely confined to mowing and weed spraying around the pond edges. De-silting is carried out reactively in response testing of sediment layer depth. Some of Canberra's large ponds and wetlands were not designed with sediment removal in mind, making it a difficult and costly exercise. As a result, many ponds and lakes appear to have water quality issues associated with re-release of pollutants from material building up within the water body (refer to **Chapter 6 Canberra's urban lakes**).

Gross pollutant traps are generally cleaned out twice per year, which is a relatively low frequency and leads to accumulation of litter, debris and sediment. Quarterly inspections of gross pollutant traps are also carried out and additional cleaning may be conducted if funds allow. This means that organic matter in gross pollutant traps decomposes anaerobically between cleanouts, causing a release of pollutants. Monitoring has shown that some gross pollutant traps are not cleaned frequently enough to prevent the release of nutrients from trapped organic matter.[263] TCCS maintains over 280 gross pollutant traps, with one round of cleaning all traps costing approximately $1.5 million.

A 2015 independent audit of the performance of stormwater treatment assets in the ACT found the operations and maintenance budget is so limited that staff describe their job as entirely reactionary. In some areas, the capacity to maintain bioretention systems and rain gardens is so limited that they are not being maintained at all, and as a result some of these systems are not working effectively. Bioretention systems are low maintenance once plants are established, but prone to failure if not maintained at all.

The audit found that asset management systems are inadequate, and maintenance plans and life cycle costing information is not being captured in current processes. There is little opportunity for operations and maintenance staff to feed useful information back to the rest of government or industry. Work to address these issues is ongoing.

The number of stormwater treatment systems has increased rapidly in the ACT over the past decade, and the maintenance budget has evidently not kept up with this increase. Inadequate levels of funding may be due to applying incorrect assumptions about the operational cost of maintaining traditional stormwater infrastructure (designed to move water away from urban areas as quickly as possible — e.g. concrete channels) to the operation of WSUD stormwater infrastructure. WSUD systems are much more complex and sensitive, and their operational requirements are correspondingly more intensive and therefore costly. This difference may not be fully appreciated by decision-makers, and therefore not appropriately funded. This can result in the construction of 'best-practice' WSUD infrastructure which then does not perform as expected due to insufficient maintenance. As discussed below, WSUD infrastructure in the ACT has been shown to be cost-effective when appropriately maintained, so this investment in maintenance is important.

### 11.6.2 Cost effectiveness of Water Sensitive Urban Design infrastructure

The ACT Healthy Waterways program was joint initiative of the ACT and Australian Governments to improve the quality of stormwater entering lakes and waterways and flowing downstream into the Murrumbidgee River system. It included civil works for 20 WSUD infrastructure projects completed in 2019. EPSDD undertook an economic evaluation of the ACT Healthy Waterways program in 2019 which included assessing the cost-effectiveness (i.e., value for money) of each of the 20 WSUD assets constructed under the program.

263. Environment, Planning and Sustainable Development Directorate, 2021. *Rectify gross pollutant trap – Kambah*. ACT Government, Canberra.

From a pollution abatement perspective, this Investigation found that WSUD assets constructed under the program were cost-effective at managing total nitrogen and total suspended solids when compared to average of estimates in other jurisdictions, but less cost-effective at managing total phosphorus. On average, the assets under this program were determined to have an average cost-effectiveness of $303 per kilogram of nitrogen. This was under the average cost-effectiveness figures in other jurisdictions estimated by Water by Design[264] and Alluvium[265] at $474. The cost of removing suspended solids (sediment) was comparable across all studies at $2 per kilogram. The program's assets were found on average to be less cost-effective at managing total phosphorus ($1827 per kilogram) compared with other jurisdictions ($1188 per kilogram on average).

Some individual assets were found to deliver lower cost-effectiveness across all three pollutants compared to average of estimates in other jurisdictions. Reasons included that some projects were not primarily undertaken for water quality (e.g., waterway restoration project which consisted primarily of riparian plantings above the waterline), or that construction was scaled back due to the discovery of matters of historical or cultural significance at the sites. However, poor water quality outcomes alone should not be taken as evidence of poor overall economic performance.

The cost-benefit analysis considered the full suite of economic benefits based on benefits and values identified within an ecosystem services framework. As well as pollution reduction, examples of other benefits include improved amenity and urban cooling.

The quantified benefits were assessed against the total costs of the program, which included the capital, ongoing operating and maintenance, and non-infrastructure costs relating to research, monitoring, program management and the behaviour change (H2OK) program. The results from the analysis indicated that based on a 30-year appraisal period, the program is economically viable with a net present value of approximately $50 million and a benefit-cost ratio of 1.66. The analysis found that the avoided pollution garnered the greatest proportion of the total benefits, followed by the benefits from improved amenity and recreation. It should be noted that the valuation of benefits other than pollution abatement were heavily based on assumptions, rather than actual study. As such, the estimates for some benefits — particularly recreation, amenity and urban cooling — may be understated.

*Strong consideration should be given to the fact that the cost-effectiveness of WSUD infrastructure is largely irrelevant when downstream developments close to the Molonglo and Murrumbidgee rivers are releasing sediment and pollutants into the river system in volumes far higher than those removed by urban WSUD infrastructure. By far the most cost-effective approach is to prevent pollutants entering our waterways in the first place.*

264. Water by Design, 2014. *Off-site Stormwater Quality Solutions Discussion Paper*. Healthy Waterways Ltd.
265. Alluvium, 2017. *Indicative costs for actions to mitigate diffuse source pollution*. Report to NSW EPA.

## 11.7 Effectiveness of governance arrangements

*Current ACT Government policies and strategies are not well integrated and do not adequately address catchment management at an urban scale. Likewise, there is currently no clear governance structure to guide strategic decision-making for protecting and improving the health of urban lakes and waterways in the ACT. This affects the broader community and special interest groups as well as internal government stakeholders. Urban waterways and water bodies perform a wide range of functions and there are disparate expectations across different parts of the community and government for the services they should provide. Many of these are incompatible with one another. This presents a challenge to the establishment of a shared vision for water quality and ecological health in the ACT.*

Strategic decision-making for the lakes and ponds needs to recognise the multiple roles that they perform and be based on a full understanding of the range of environmental, social and economic values that they provide. For instance, large ponds which were designed to treat stormwater have also become important community assets, and there is an expectation by the community that they will be protected from the impacts of future development in their catchments. It appears that in some contexts they are considered as treatment systems but in others they are considered as receiving waters in their own right. There also appears to be no coordinated management of urban waterways, with reliance on community-based volunteer efforts such as Waterwatch for monitoring and local catchment groups for revegetation.

A snapshot of the key issues of concern is illustrated in the work of the Lake Burley Griffin Guardians, a community group established to protect the lake and its environs. One of the main functions of this group is to '*interact with any organisation involved with management or use of the Lake, to better acquaint with their roles and needs*'.[266] They also express concern about '*the lack of adequate institutional reform and intergovernmental arrangements to ensure an overarching management of the Lake*'. While Lake Burley Griffin is admittedly a uniquely complex example due to the inter-jurisdictional nature of its management arrangements, the concerns of this group illustrate the frustrations of many in the ACT with regard to understanding the many different entities involved in management of lakes, waterways and the public spaces surrounding them.

### 11.7.1 An ACT Office of Water

As discussed above, there is no clear governance structure to guide strategic decision-making for protecting and improving the health of urban lakes and waterways in the ACT. An agency that is responsible and accountable for integrated catchment management at an urban scale and for making strategic decisions for the urban lakes, ponds and waterways, including stormwater management in the ACT, is needed.

266. Website of Lake Burley Griffin Guardians: https://lakeburleygriffinguardians.org.au/our-mission-and-objectives/

A recent review of water governance arrangements by EPSDD examined the role that an Office of Water[267] could provide to clarify (or reset) the vison, objectives and goals for the water sector; improve coordination on cross-cutting issues; clarify roles, responsibilities and accountabilities; support improved capacity and capability; and improve public communication. A proposed model for the Office of Water is currently with the ACT Government for consideration.

To address the issues raised in this Investigation, the proposed :

- aim to develop a catchment management strategy for urban areas through collaboration with key stakeholders and based on understanding of processes and interactions at the local and broader catchment scale
- have the capacity to operationalise and implement the strategy — the responsibility for implementation of many current strategies is shared across multiple teams and entities, and this appears to be one of the reasons for delivery failures, and
- align its activities, within an urban context, to the actions under Outcome 1 of the *ACT Water Strategy — Healthy catchments and waterbodies: well-managed, functioning aquatic ecosystems that protect ecological values and contribute to the liveability of the ACT community.* The catchment management strategy should guide application of the *Waterways: WSUD General Code*, including how 'development targets' and 'regional targets' for stormwater treatment will be applied to meet the ACT Water Strategy.

An important element will be to develop a shared vision for the urban lakes, ponds and waterways and to recognise the multiple roles that they perform including water quality management, and the range of environmental, social and economic values that they provide. **Chapter 10** outlines many of the organisations involved in water management and governance in the ACT, and bringing together the perspectives of these diverse stakeholders is both challenging and essential.

Facilitating legislation would be required to provide sufficient authority for the effective undertaking of this role by the proposed Office of Water. This role should specifically include working collaboratively with other agencies within the ACT Government, Icon water, National Capital Authority, NSW Government and local governments in NSW within the catchments relevant to the ACT. It should collaborate with the entities and agencies responsible for implementing the *ACT Living Infrastructure Plan*. It should be responsible for developing and implementing the 'holistic water cycle management plan' which is scheduled to be developed 2020–21 as per *Implementation Plan Two of the ACT Water Strategy.* This entity should work with the ACT and Region Catchment Management Coordination Group (CMCG) where cross-jurisdictional matters are concerned e.g., for management of Lake Burley Griffin.

Whilst the proposed Office of Water will provide a technocratic approach to catchment planning and management, it is also critical that consideration is given to facilitating inclusion of diverse forms of knowledge and that the community is involved in deliberative decision making. A mechanism for integrating perspectives from existing community catchment and water forums and networks must be a

267. Environment, Planning and Sustainable Development Directorate, 2021. *ACT Water Governance Review fact sheet*. ACT Government, Canberra.

key consideration in the development of the Office of Water or equivalent entity. It is critical that a 'bottom-up' approach is adopted, where the diverse forms of knowledge held within the community are recognised and fostered. This is because there is significant community interest in the management of water and land resources in urban areas (e.g., Waterwatch, Landcare, Catchment Groups). Many ponds and lakes are viewed by the community as important community assets. The ACT Government has already begun to explore using deliberative democracy for environmental issues and continuing this was recommended in the most recent ACT State of the Environment report (CSE 2019, recommendation 8). This approach, together with other genuinely consultative processes, should be integrated into the operation of the Office of Water.

## 11.8 Effectiveness of monitoring, evaluation and reporting processes for urban waters

The ACT Government has specified numerous objectives and targets related to water quality and management. For example, in 2002 the ACT Legislative Assembly passed a motion that the water leaving the ACT via the Murrumbidgee River should be of no less quality than the water flowing into the ACT. More recently, the 2014 *ACT Water Strategy 2014–44: Striking the balance* lists a range of targets and indicators to inform water management on the condition of ACT waters and the effectiveness of management activities.[268] The strategy also includes objectives to improve knowledge for planning and investment decisions.

However, this Investigation has found that current monitoring programs and the data they collect are not sufficient to address performance against the objectives and targets set by the ACT Government for water quality and aquatic ecosystem health. The main issues that impact on the comprehensiveness and relevance of current water monitoring programs are discussed below, as are recommended steps to improve the ACT's knowledge on urban waters.

This Investigation, and the ACT Government itself, relies heavily on the urban waterway monitoring undertaken by Waterwatch volunteers. Without Waterwatch, the spatial coverage of available data would be severely reduced, as would the range of data available. For example, Waterwatch not only undertakes water quality monitoring but also assessments of aquatic ecosystem health through macroinvertebrate and riparian surveys, and the distribution and abundance of platypus. In addition, frog surveys undertaken by Frogwatch contribute most of the knowledge on frog populations in the ACT. This Investigation has found that government monitoring programs in ACT urban waterways often play a supporting role to citizen science programs, rather than the other way round. That the ACT is dependent on citizen science to provide the bulk of its urban water data can be seen as both an acknowledgement of the quality of data produced by Waterwatch and of the inadequacy of the current urban water monitoring by the ACT Government.

The value of Waterwatch monitoring data, combined with the dependence on Waterwatch to monitor urban waters in the ACT, demonstrates the importance for ongoing government commitment to fully support and resource citizen science programs in the ACT.

268. Environment and Planning Directorate, 2014. *ACT Water Strategy 2014–44: Striking the balance.* ACT Government, Canberra.

### *Key actions for monitoring, evaluation and reporting*

The ACT Government should:

**Key Action 11.9:** Provide secure, sufficient and ongoing funding to the Upper Murrumbidgee Waterwatch program.

**Key Action 11.10:** Develop methodologies for assessing performance against published urban water management outcomes, objectives and targets.

**Key Action 11.11:** Determine the data required to comprehensively assess urban water quality, aquatic condition, and management effectiveness. This should include the methodologies required to obtain such data, and steps to ensure accuracy and consistency of monitoring across the ACT.

**Key Action 11.12:** Review urban water monitoring and management activity reporting in the ACT and identify opportunities for improved collaboration and coordination across government and community monitoring programs. The review should also identify opportunities to increase the usage and relevance of monitoring and management data across monitoring programs and improve accessibility for government and community stakeholders.

**Key Action 11.13:** Increase the number of flow gauging stations in Canberra's urban waterways. This will require the identification of flow data priorities to improve knowledge for water management.

**Key Action 11.14:** Improve the spatial and temporal coverage of current water quality monitoring programs including the incorporation of long-term key sites and periodic targeted monitoring. This should be supported with a review of current government and community water quality monitoring to identify the spatial and temporal data gaps that limit the assessment of management effectiveness and the identification of water quality issues.

**Key Action 11.15:** Undertake a review of urban water data collected and held across ACT Government and assess and rectify issues of quality and accessibility of databases.

**Key Action 11.16:** Provide community access to urban water data through an online platform.

**Key Action 11.17:** Produce comprehensive annual water reports to better inform managers and the community on urban water condition and management performance, including management priorities and activities undertaken to respond to identified water issues.

**Key Action 11.18:** Produce a regular five to 10-year evaluation of trends and patterns in urban waterway health using Waterwatch data.

**Key Action 11.19:** Report annually on recreational water quality combining ACT managed waters and results from Lake Burley Griffin monitoring undertaken by the National Capital Authority. Reports should include annual closures, relevant pollutant assessments, pollution sources and management actions and effectiveness.

**Key Action 11.20:** Develop indicators for reporting on the condition and management of urban waters and recreational water quality. This should include assessment methodologies to ensure consistency and comparability of findings over time.

### 11.8.1 Lack of direction for water monitoring programs

The multiple strategy, planning and guideline documents that relate to urban waters outline high level policy objectives but provide little detail on the required information necessary to demonstrate management effectiveness. Nor do such documents provide the required approach to obtain such information. This applies to all levels of policy including target setting and the audit and assessment of objectives. This means that there is little direction on the development of monitoring programs and the data they should collect to comprehensively inform management priorities and to assess the success (or otherwise) of management actions. Similarly, this Investigation has identified a limited management framework and responsibility around the collection of water samples and data on algal blooms and lake closures. Macroinvertebrate sampling programs conducted by government and by Waterwatch volunteers are also poorly integrated, both with one another and with ACT monitoring programs more broadly.

The lack of policy direction on the methodology required to assess urban water management performance is the main cause for the significant data and knowledge gaps found in this Investigation. Although there is quite a lot of water quality data collected for urban waters, these are not necessarily the data that are needed to evaluate management objectives. For most urban waters, the data available does not allow a comprehensive assessment of aquatic condition, compliance with specified guidelines or the effectiveness of management actions. Such data gaps have serious implications for the adaptive management of water quality and public health outcomes, particularly for the identification of management priorities and the most effective allocation of resources.

Further complicating the adequacy of current monitoring programs is the poor collaboration between water managers. As discussed above, across the ACT, the range of agencies responsible for various aspects of urban water quality and aquatic health appear to lack an overarching systematic approach to urban waterway management, and this includes monitoring programs. The lack of a systematic approach has resulted in aquatic monitoring programs with little coordination and integration across the ACT. Consequently, much of the ACT's data is only relevant to specific management purposes which limits the broader use and cost effectiveness of monitoring activities.

### 11.8.2 Data gaps

This Investigation has found significant gaps in urban water monitoring data that limits the assessment of environmental condition and management effectiveness. Improved data on urban water quality and aquatic health will depend on significant changes to the monitoring and reporting approach currently undertaken by the ACT Government. The main data gaps and suggested measures to address them are discussed below.

#### Lack of flow monitoring

Flow data from the urban stormwater network is sparse at best and non-existent for many waters. This means that the relative pollutant and flow contributions from urban runoff are currently very poorly understood. Given the notable contributions of nutrients (particularly dissolved) and sediment to urban lakes, ponds and wetlands, there would be great value in gaining some understanding of the flows in the urban stormwater network and the pollutants they transport.

To address the lack of flow data, more gauging stations need to be installed on urban waterways. Research will be required to identify the optimum locations for these stations within the main waterway reaches and in the main inflows for each of Canberra's urban waters. Decisions on extending the flow gauging network should consider priority issues such as the sources of pollution to Canberra's urban lakes, as well as identifying urban catchments for which flow data is absent or poor.

#### Temporal and spatial limitations

A key data gap, and one of the main challenges for improving the ACT's water quality data, is the limited temporal resolution of the data. While Waterwatch monitoring provides valuable regular monitoring of urban waterways, it is limited to monthly sampling and often does not capture high–flow events. Given that a large portion of nutrients, sediment and other urban pollutants are transported in high flow events (during heavy rainfall), the available monthly water quality data is prone to missing vital pollutant data that would be obtained from more frequent sampling or by event-based sampling.

The lack of stormflow data also has significant consequences for water quality assessments and the accuracy of reporting. Reported water quality findings, including this Investigation, are generally biased toward more positive findings because most of the data is collected under low flow conditions. This means that the findings presented are often misleading, overestimating aquatic health and management effectiveness.

Although it is costly to undertake continuous monitoring of water quality, and event-based sampling is particularly challenging, this would provide key information on the levels of water pollution in urban waters during times of peak pollution. Without improved stormwater flow and water pollution data, it is not possible to fully determine the performance of water sensitive urban design infrastructure, the capacity of urban lakes to intercept pollution and protect downstream waters (including the Murrumbidgee River), and the ability to accurately assess performance against specific targets for pollutant loads.

In addition to temporal coverage, current monitoring is limited by spatial coverage. For example, the lack of monitoring data for the upper reaches of Ginninderra Creek is a significant knowledge gap. The current spatial gaps are somewhat related to the ACT's dependence on Waterwatch monitoring, with data availability often determined by sites selected by Waterwatch and the availability of volunteers to undertake monitoring activities. In such cases, it should be the responsibility of the ACT Government to undertake the required monitoring or to provide resources for Waterwatch to do so.

### Addressing temporal and spatial limitations

Improving temporal and spatial data will be difficult given the cost and resources required for extensive monitoring programs, continuous monitoring, and event-based sampling. Consequently, decisions need to be made on data priorities to determine where monitoring needs to be undertaken. This can be in response to data gaps or management and community concerns. Priorities can then be used to direct more comprehensive and targeted monitoring to quickly provide the data required for management intervention. Such targeted monitoring would provide more useful data compared to adopting a more broadscale and low sampling frequency program.

Targeted monitoring for ACT urban waters could be achieved through a combination of approaches, including:

- **Monitoring of key sites** – a number of monitoring sites could be selected to provide long-term and more frequent data on high priority waters. For example, sites upstream and downstream of the urban lakes and ponds that are considered to be vital water quality controls or end-of-system sites to determine catchment condition. These sites would provide an overall picture of the health of urban catchments, potential issues and management effectiveness. Key site monitoring could also be enhanced by including biological assessments (macroinvertebrates) and flow assessments.
- **Periodic targeted monitoring for adaptive management** – water quality and other monitoring could be applied to sites with known issues and emerging pressures or to assess management activities and the performance of water quality infrastructure. Such monitoring would be temporary and be designed to provide the detailed and timely data required by managers for adaptive management. For example, targeted monitoring could be used to assess the impacts of land development, enabling rapid decisions on the need for improved water quality interventions. Targeted monitoring could also be used to assess the performance of water pollution control ponds during high flow conditions.

In the absence of monitoring, dedicated research can address some knowledge gaps. Such studies are invaluable for understanding the water quality in urban waters. Especially as the more frequent data collection undertaken for research has a much greater probability of capturing the impacts of high pollution events.

### 11.8.3 Data management, reporting and accessibility

Processes for managing and recording data are notably constrained by agency resourcing. This has resulted in datasets that are lacking in quality or are difficult to access and use. Consequently, this Investigation has experienced great difficulty in reviewing, analysing and interpreting the available data used to determine urban aquatic health and water quality. In particular, there appears to be a lack of quality control and assurance processes for water quality data and information. This Investigation has noted a number of instances where the water quality readings have been implausible or should have raised substantial management concerns.

Better quality and more accessible databases would greatly improve water management information. Accessibility could be improved by having databases available on an online platform similar to the Bureau of Meteorology water data online website and the ACT Government's ACTmapi platform. Such work would also necessitate a comprehensive review of existing water quality and management databases and data holders.

To improve urban water management, data on water quality and aquatic health needs to be available to all relevant stakeholders, including across government, the community and non-government agencies. Given the reliance of the ACT on the data collected by Waterwatch community volunteers, as well as on other community groups to undertake management activities, community access to water data is considered a priority to help inform volunteer activity and decision-making. This will most likely require a community accessible database that is both well maintained and developed with non-specialists in mind.

#### Reporting on the condition and management of urban waters

There is a lack of public reporting on urban waterway condition that includes an evaluation of the effectiveness of management actions and recommendations for improvement. In the past, the ACT Government produced a series of annual Water Reports that summarised water management, water quality, and aquatic ecosystem health in the ACT.[269] These reports included data trends, recommendations and management responses. They have not been produced since 2015, being replaced by less comprehensive annual *ACT Water Strategy* report cards[270]. It would be beneficial for urban water managers and the community if the more comprehensive annual water reports were reinstated, not only to demonstrate the condition of urban waters but also to better inform managers and the community on urban water management and the performance of water sensitive urban design measures. Such reports should include dedicated content on management priorities and the intended or recommended approaches to resolving identified water issues.

269. Environment and Planning Directorate, 1996 to 2015. *ACT Water Reports*. ACT Government.
270. Environment, Planning and Sustainable Development Directorate, 2021. *ACT Water Strategy 2021 Report Card*. ACT Government, Canberra.

The need for a reporting framework for aquatic ecosystem health and water quality was identified by the Commissioner for Sustainability and Environment in the *2019 ACT State of the Environment Report* under Recommendation 29: *Establish a government reporting framework for the assessment of aquatic ecosystem health and water quality. This should incorporate work undertaken for the Catchment Health Indicator Program and produce public reports at appropriate intervals to provide meaningful assessments.*[271]

This Investigation has found that some of the best available urban waterway data comes from the Waterwatch program. It would be beneficial to use Waterwatch data to produce a regular five to 10-year evaluation of trends and patterns in urban waterway health. This data that would provide far more comprehensive coverage than was possible for this Investigation. It should be noted that such a data assessment would be a significant exercise and would require substantial investment and assistance from the ACT Government.

It would also be beneficial for the ACT Government to report annually on recreational water quality. However, this would require significant improvements to the current ACT Government datasets for recreational water quality, with the data particularly poor for lake closures in Lake Ginninderra and Lake Tuggeranong. For example, the data have not been consistently recorded, with records unavailable prior to 2015. There is also difficulty in accessing recreational water quality data sets (cyanobacterial counts and enterococci), along with the useful field observations from samplers.

Because closures are key indicators of the recreational amenity of the lakes, it is important that such data is accurate, long term and accompanied by supporting information. Annual recreational water quality reports could combine both ACT managed waters and results from the Lake Burley Griffin monitoring undertaken by the National Capital Authority. These would provide a comprehensive report for all recreational waters in the ACT. Reports should also include information on the main pollution sources which cause recreational closures (which can then be used to inform the management of inflows), management actions undertaken or required to improve water quality, and assessments of management performance.

The need for annual reporting on recreational water quality was identified by the Commissioner for Sustainability and Environment in the 2019 State of the Environment Report under Recommendation 28: *Produce an annual recreational water quality report that includes monitoring results, investigations into the main sources of pollutants, recommended actions to improve water quality, and assessments of management effectiveness*.[272]

271. Office of the Commissioner for Sustainability and the Environment, 2019. *ACT State of the Environment 2019*. Canberra.
272. Office of the Commissioner for Sustainability and the Environment, 2019. *ACT State of the Environment 2019*. Canberra. https://envcomm.act.gov.au/soe_about-the-report/

*Use of indicators for reporting*

For any instituted ongoing reporting programs on urban and recreational waters (including any future state of the lakes and waterways reporting), it is recommended that indicators are used to ensure assessments are relevant to information needs and are consistent and comparable over time. The identification of core indicators that are relevant to all urban water types would enable the compilation of an overall picture of urban water quality across the ACT. Other indicators specific to waterbody types and their associated values should then be added to provide a comprehensive overview of urban water condition and management.

The indicators can be developed from the noted values, outcomes and targets in dedicated urban water management plans and strategies, and from specific data needs to enable robust assessments of urban water condition. However, any development of indicators must be accompanied by assessment methodologies to ensure consistency and comparability of findings over time.

The use of indicators would also facilitate the inclusion of urban water assessments in other reporting programs including the ACT State of the Environment and the ACT Wellbeing Framework.

*Macroinvertebrate survey in Tuggeranong Creek. Source: Miranda Gardner*

# 12 Urban development and the ACT's lakes and waterways

*Urban development in the ACT. Source Google Maps.*

## Contents

The ACT's population is projected to grow to around 703,000 by 2058.[273] This represents an increase of around 292,000 people from 2017 — a growth of more than 70 per cent. Such growth will significantly increase demand for housing, services, utilities and associated infrastructure in the ACT. This will exacerbate the threats from poor urban water quality to the Molonglo and Murrumbidgee Rivers downstream of Canberra.

Whilst the ACT Government has a target for up to 70 per cent of all new housing to be provided as **infill development**[274] within the existing urban footprint, the remaining 30 per cent would be in **greenfield sites**[275] (previously undeveloped land).[276] It is estimated that the ACT will need 100,000 new dwellings by 2041 to accommodate the projected population growth. Such growth will also require significant construction of associated infrastructure. Current estimates suggest there is potential for approximately 29,000 new homes in existing greenfield areas zoned as future urban areas. This means that there will likely need to be new greenfield areas rezoned for urban development,[277] which will add further impacts to waterways beyond increased construction activity alone.

## 12.1 Impacts of construction

The construction phase of development can be highly detrimental to aquatic ecosystems. In the ACT, this is largely due to the sedimentation pollution caused by construction activity. Not only does sediment often contain other pollutants but also too much sediment entering receiving waters can smother habitat and food sources for platypus and native fish, affect water chemistry, and alter flow regimes when it is deposited further downstream (see **5.1 Impacts on urban lakes and waterways**). Specifically in the ACT, this includes sediment building up in Burrinjuck Dam, which supplies water to the Yass region and beyond. Excess sediment may also produce conditions which are more favourable to invasive species such as carp.

As well as impacting receiving waters, poor erosion and sediment control during construction has a significant impact on stormwater treatment assets designed to protect those waters, sometimes rendering assets ineffective. This is especially the case where these have been put in place before house-building has started in a development or where a new estate is later developed in the catchment upstream of the asset. It is regularly reported that stormwater treatment assets are damaged or compromised by building and other construction activity, with heavy siltation in the assets often cited as a key issue.

273. Chief Minister, Treasury and Economic Development Directorate, 2019. *ACT population projections 2018 to 2058*. ACT Government, Canberra.
274. Infill developments refer to the construction of buildings or facilities within existing urban areas.
275. Greenfield sites refer to undeveloped land in an urban or rural area.
276. Environment, Planning and Sustainable Development Directorate, 2018. *Planning Strategy 2018*. ACT Government, Canberra.
277. Ibid.

The *Environmental Protection Guidelines for Construction and Land Development*[278] require developers and builders to put erosion and sediment controls in place and to be responsible for the damage they cause. The quality of erosion and sediment control measures is highly variable in the ACT, with a range of mitigation approaches and differing standards of execution across sites managed by different builders and developers. In practice, it can be difficult to predict and plan for exactly how a site will be impacted by erosion. Even well-built and -maintained sediment control measures can be overwhelmed during periods of intense rainfall. This is particularly a concern for impacts on the Molonglo and Murrumbidgee Rivers from development on the ACT's western edge — developments are very close to both waterways with limited space to intercept sediment before it reaches the rivers.

As discussed earlier in this Investigation (see section **11.8**), the ACT Government's current monitoring programs, which are based largely on monthly data collection, often fail to detect this type of pollution event. As a result, their broader impacts on water quality are poorly understood. While monitoring of erosion and sediment control measures is a requirement for constructions workers onsite, their results are not publicly available. There have been a number of occasions where community members and Waterwatch volunteers have identified problems with sediment control measures, and voiced their concerns.[279, 280]

A more proactive approach to compliance monitoring could assist with identifying water quality impacts arising from inadequate or damaged sediment control infrastructure.

As seen in the photos below, it is standard practice in the ACT (as elsewhere in Australia) to remove all vegetation and some topsoil from large swathes of land earmarked for development well before any construction work commences. This is done to prepare the site for bulk earthworks, an essential part of estate-scale development, which are impractical and expensive to do on a small scale. This approach means that areas are then exposed to the elements, sometimes for long periods, resulting in extended periods of time when sediment can be blown or washed away (Figure 12.1).

**Figure 12.1.** Sediment laden water in (left) Giralang Pond (June 2016) and around the Casey Development (June 2013).
**Source:** ACT Waterwatch.

278. Environment Protection Authority, 2011. *Environment Protection Guidelines for Construction and Land Development in the ACT*. ACT Government, Canberra.
279. Tindale, L., 2021. Denman Prospect, *Whitlam developments threaten platypus population in ACT: Woo O'Reilly*. The Canberra Times, Canberra. https://www.canberratimes.com.au/story/7367488/denman-prospect-whitlam-developments-threaten-platypus-population/
280. Ginninderra Falls Association Committee: https://ginninderra.org.au/node/789

Sediment capture ponds typically in use during construction are small compared with the large catchment areas from which they collect sediment (Figure 12.2). This means that the ponds can fill with sediment well before construction is complete and, if not regularly cleaned out, do not function effectively to capture soil run-off and protect waterways downstream. The updated *Environmental Protection Guidelines for Construction and Land Development*, which are due to be published shortly, recognise the need to increase the capacity of sediment control ponds based on climate change projections which predict more frequent and intense rainfall events. WSUD infrastructure may also perform multiple functions during the construction process (e.g. a sediment capture basin may be repurposed as a wetland), which presents difficulties in terms of design when these functions are incompatible with one another. This is discussed further in section **11.6**.

**Figure 12.2.** Aerial images of urban constructions areas in Taylor (upper image) and Denman Prospect (lower image). The colour of the water in the ponds downstream of the construction areas show these are loaded with sediments. Even when many ponds are used sediment can still build up quickly after heavy rain.

**Source:** Google Maps

The impacts of construction at smaller-scale infill sites within existing suburbs should also not be underestimated. The three images below (Figure 12.3) show knockdown-rebuild developments on suburban blocks within a few streets of each other within the same year. Based on these observations, failure to effectively control sediment runoff from this type of site appears to be common. While each of these sites may not have a major effect on stormwater quality when considered in isolation, collectively such developments are likely to contribute significantly to the sediment loads in urban stormwater.


**Figures 12.3.** Three examples of small-scale infill development with poor sediment control in Canberra.
**Source:** Miranda Gardner

The issue of sediment runoff from construction sites is exacerbated by an apparent lack of compliance and enforcement activities in the ACT, as described in **12.3 Compliance and enforcement of water protection measures** below.

Many of the above examples occurred during a period of unusually high rainfall. While short duration high rainfall events are difficult to predict and prepare for, such rainfall events are projected to occur more frequently under modelled climate change scenarios. Furthermore, sediment pollution from construction activities in the ACT is not a new or transient phenomenon. Hence, lessons from this period of heavy rainfall must be taken on board by developers and regulators to inform a more rigorous approach to erosion and sediment control for urban developments.

## Deep Creek Case Study

Targeted monitoring of Deep Creek, which drains the developing suburb of Whitlam, has been undertaken as part of the ACT Healthy Waterways monitoring program. This provides a valuable case study that highlights the challenges of urban development in the ACT.

Deep Creek is a short ephemeral creek that drains directly into the Molonglo River downstream of Lake Burley Griffin. A significant portion of the Deep Creek catchment is being developed to create the suburb of Whitlam. Standard sediment and erosion control measures have been implemented within the development area. These include silt fences, temporary sediment basins and further sediment detention ponds.

Despite the implementation of erosion control measures, high levels of sedimentation have been observed in Deep Creek since construction. Concentrations of suspended solids in the creek were rarely within the acceptable range for ACT waterways (Figure 12.4) and often reached extremes of sediment concentrations during construction in 2019 and 2020. Existing sediment control infrastructure has been observed to be of very limited effectiveness (Figure 12.5) and the sediment detention ponds on Deep Creek have failed multiple times (Figures 12.6 and 12.7) leading to high suspended sediment loads being delivered directly into the Molonglo River downstream of Lake Burley Griffin (Figure 12.8). While the Deep Creek catchment is a particularly challenging site in which to control sediment runoff, failures of sediment control measures associated with construction in the ACT are not uncommon (e.g., Figure 12.9) and images of sediment laden urban waterways are not unusual (Figure 12.8).

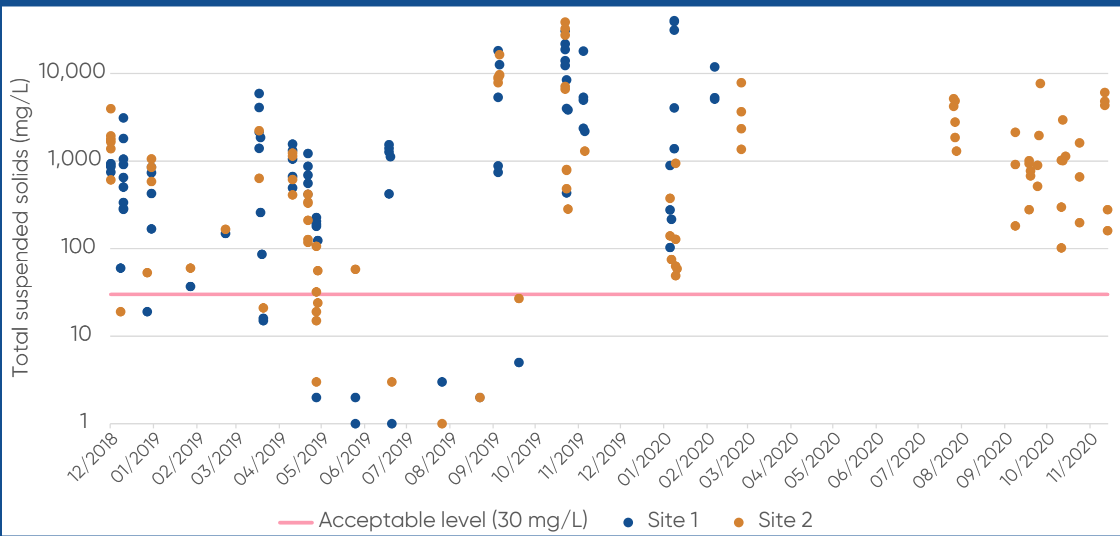



**Figure 12.4**. Suspended sediment concentrations recorded at two stations on Deep Creek in 2019 and 2020. The pink line shows the maximum acceptable range for suspended sediment for aquatic ecosystems in the ACT.

**Data sourced from:** ACT Healthy Waterways Program.

**Note:** Data from June 2019 to November 2020.

**Figure 12.5.** Sediment entering Deep Creek from construction areas illustrating the failure of silt fencing to contain the mobilised sediment. February 2020.
**Source:** ACT Waterwatch

**Figure 12.6.** Deep Creek sediment detention pond illustrating the failure of the pond to trap fine sediments. June 2020.
**Source:** ACT Waterwatch

**Figure 12.7.** Failure of the Deep Creek sediment detention pond wall, February 2020.
**Source:** ACT Waterwatch

There is a substantial need to improve the erosion and sediment control activities associated with urban development in Canberra to protect our urban waterways, as well as the surrounding waterways which are becoming increasingly urbanised. This requires attention across the ACT's planning and regulatory systems. Future developments need to better consider the impacts of sedimentation and be held accountable for minimising the downstream impacts. This will be more costly for the developments but failing to address these issues fails to fully account for the true cost of developing new suburbs.

**Figure 12.8.** Deep Creek confluence with the Molonglo River.
**Source:** ACT Waterwatch

In response to the failures of the Deep Creek water quality control infrastructure detailed here over the period to 2020, the ACT Government has since implemented a range of actions to improve sediment control from the Whitlam development. It is hoped that these measures implemented beyond business as usual in Whitlam will reduce sedimentation issues in Deep Creek and the impacts on the Molonglo River.

**Figure 12.9.** Poorly maintained silt fencing associated with urban development in the ACT.
**Source:** ACT Waterwatch

## 12.2 Impacts of greenfield development

As befits the Bush Capital, Canberra is surrounded by rural and semi-natural areas with only a scattering of roads and buildings and large amounts of vegetation. Most of the rain which falls on these areas is absorbed into the soil and receives some degree of filtration before seeping into rivers of groundwater. Consequently, this water is generally of high quality with low levels of pollutants and sediment. In contrast, rain falling on an urban area generally runs over hard surfaces such as roads, picking up litter and pollutants on the way. It then flows directly into a drain or pond with minimal filtration by the soil or plant roots. This means that simply changing an area of land from rural or natural use to urban use will have an unavoidable negative impact on water quality.

Over the reporting period of this Investigation (2010 to 2021), Canberra's urban area has seen significant growth, including a number of new 'greenfield' residential developments (construction occurring on formerly rural land). These new developments have added another 922 hectares of urban land to the ACT. The main development areas are:[281]

- Macnamara (174 hectares) and Strathnairn (133 hectares) in West Belconnen in the Murrumbidgee River and Ginninderra Creek catchments, and
- Molonglo (92 hectares), Denman Prospect (304 hectares) and Whitlam (219 hectares) in the Molonglo River catchment.

The ongoing urban development and densification in the ACT is increasing the pressure on our urban waterways through increased pollutant loads and modifications to waterways. The landscape changes made by the conversion of rural land to urban areas is significant. Figure 12.10 shows the extent to which urban areas have encroached into rural and natural landscapes in the Molonglo Valley between 2004 and 2021. Significantly, the Molonglo River flows through the middle of this development area, making it especially susceptible to pollution from the new suburbs. This also shows the new development of Whitlam on a steep slope close to the river. The construction of this suburb has resulted in substantial amounts of sediment entering the Molonglo River, including via Deep Creek (refer to **case study**).

281. Suburb obtained from 2011 and 2021 Territory Plan. Data supplied by the Environment, Planning and Sustainable Development Directorate. Areas are totals for lands classified as residential, commercial, transport and services.

Canberra's urban growth in the Molonglo Valley and western edge developments is particularly concerning for the ACT's current and future aquatic health. These developments are downstream of all urban lakes and so drain directly into the Molonglo and Murrumbidgee Rivers. There is no space to construct additional urban lakes on the scale of Ginninderra, Tuggeranong and Burley Griffin, which means that there is no possibility for a large urban lake to intercept and trap the high loads of pollutants transported in urban runoff. This is especially pertinent during heavy rainfall periods when ponds, wetlands and other smaller WSUD infrastructure can be overwhelmed. Consequently, the Molonglo Valley and western edge development areas have the potential to significantly degrade downstream aquatic health by increasing the concentrations of pollutants entering the Molonglo and Murrumbidgee Rivers.

Recent investigations[282] have also shown that current stormwater management in the new suburbs does not adequately consider the impacts of large volumes of stormwater from the new urban areas above the Murrumbidgee and Molonglo Rivers. In the Lower Molonglo River, many stormwater discharge points from the Coombs, Denman Prospect and Molonglo developments are situated at the Molonglo River reserve boundary. This means that the reserve itself is now being eroded by stormwater from the new developments, resulting in habitat damage within the reserve and sedimentation in the river below. Water quality and weed infestation issues may arise over time. These discharge points now require additional treatment, potentially including options such as level-spreaders, rock-lined waterways, engineering drainage structures and the use of appropriate vegetation to stabilise discharge areas and manage flows. This infrastructure will be expensive to build and maintain, and could potentially have been avoided through better design.

## Future urban expansion

In addition to the new suburbs already being built, the ACT Planning Strategy has identified large areas for potential urban development (Figure 12.11). The location of these potential new urban areas, particularly along the western edge of Canberra's existing urban area (known as the Western Edge Investigation Area), will have significant implications for the health of the ACT's waterways and the downstream impacts of the ACT on the Murrumbidgee River.

If they go ahead, the new developments will require substantial improvements in the management of water pollution compared with those which have been recently constructed to ensure impacts on aquatic health are minimised.

To avoid or minimise impact, stormwater management principles in new developments should aim to reduce impervious areas and enhance permeability across the development. Swales, vegetated waterways, wetlands and ponds should be used to manage stormwater flow in preference to pipes and lined channels. Measures to increase **detention**[283] and **retention**[284] capacity, such as capture and reuse, rain gardens, and retarding basins should also be incorporated where feasible. These principles need

282. Alluvium, 2020. *Western Edge Investigation Area – Water Values and Environmental Hydrology Assessment*. Technical report prepared for the ACT Government (EPSDD), Canberra.
283. Detention is where water is held permanently in the landscape, for example in a tank or pond, rather than being released into receiving waters.
284. Retention is where water is held temporarily to prevent intense peak flows and flooding, for example in a wetland where water moves slowly through a system of ponds before being released into receiving waters.

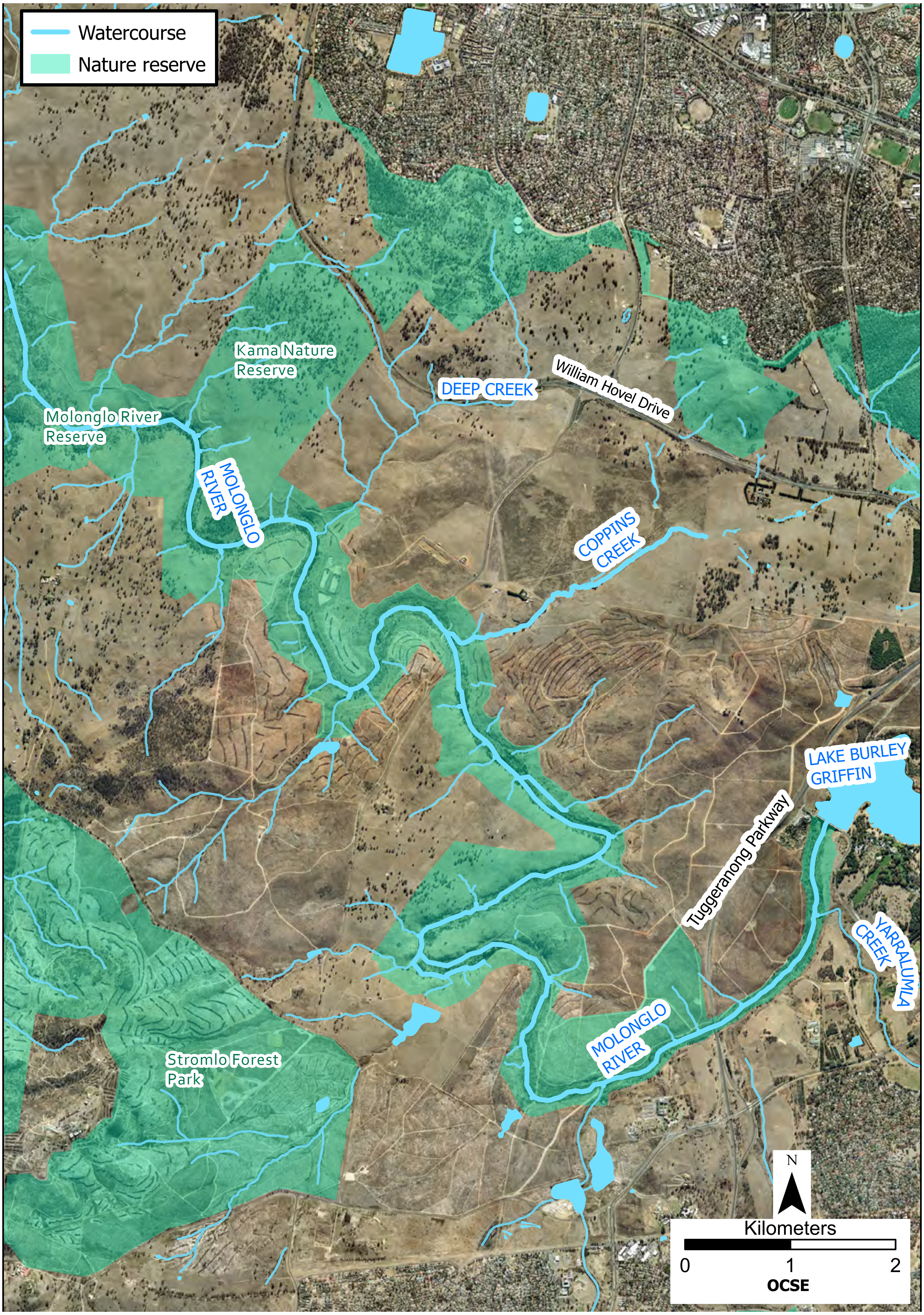



**Figure 12.10a.** Satellite images of land development in the Molonglo Valley, 2004.

**Source:** ACT Government.

**Note:** Future Urban Area refers to future urban land for the purposes of Section 51 (2) (a) of the Planning and Development Act 2007.

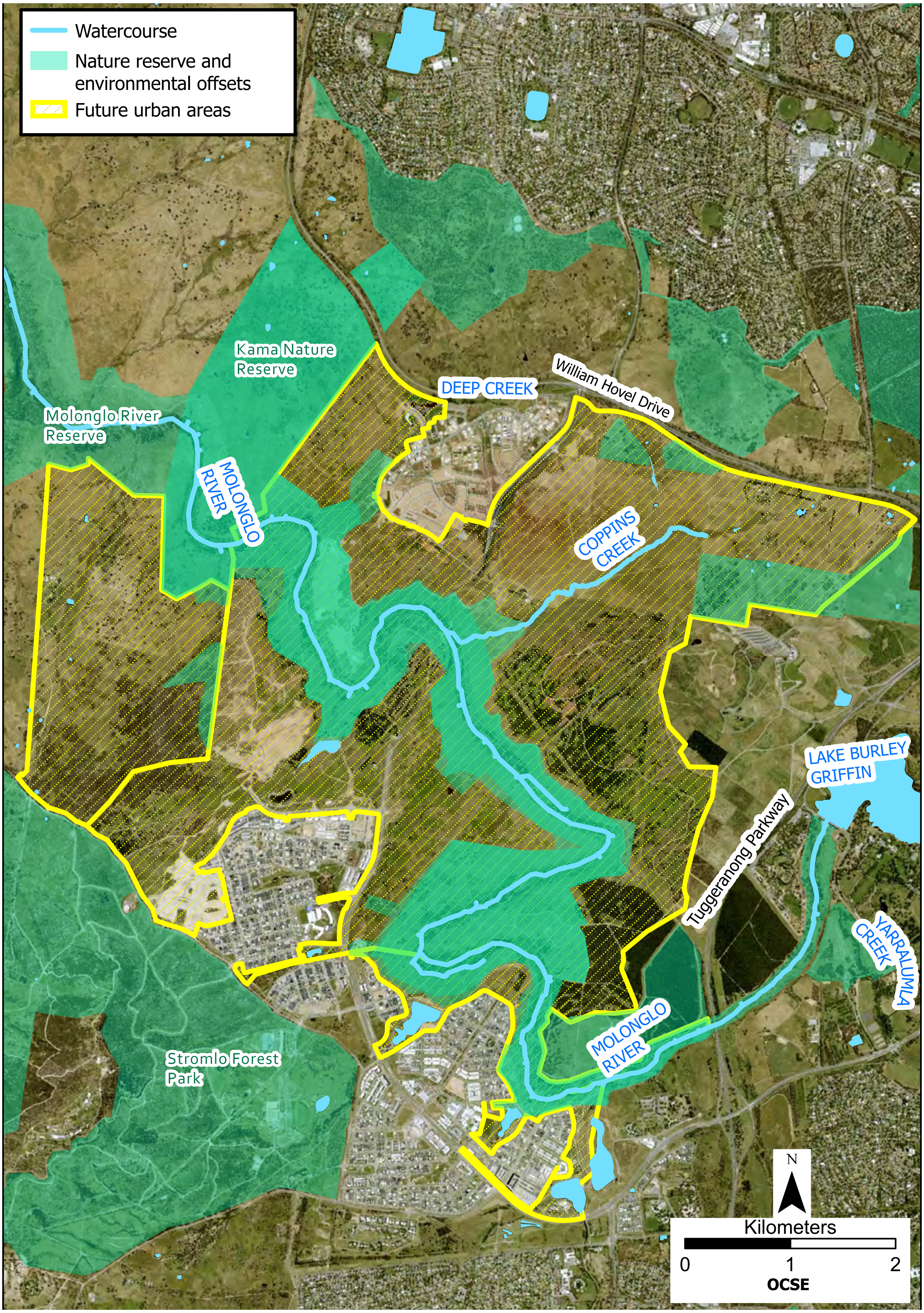



**Figure 12.10b.** Satellite images of land development in the Molonglo Valley, 2021.

**Source:** ACT Government.

**Note:** Future Urban Area refers to future urban land for the purposes of Section 51 (2) (a) of the Planning and Development Act 2007.

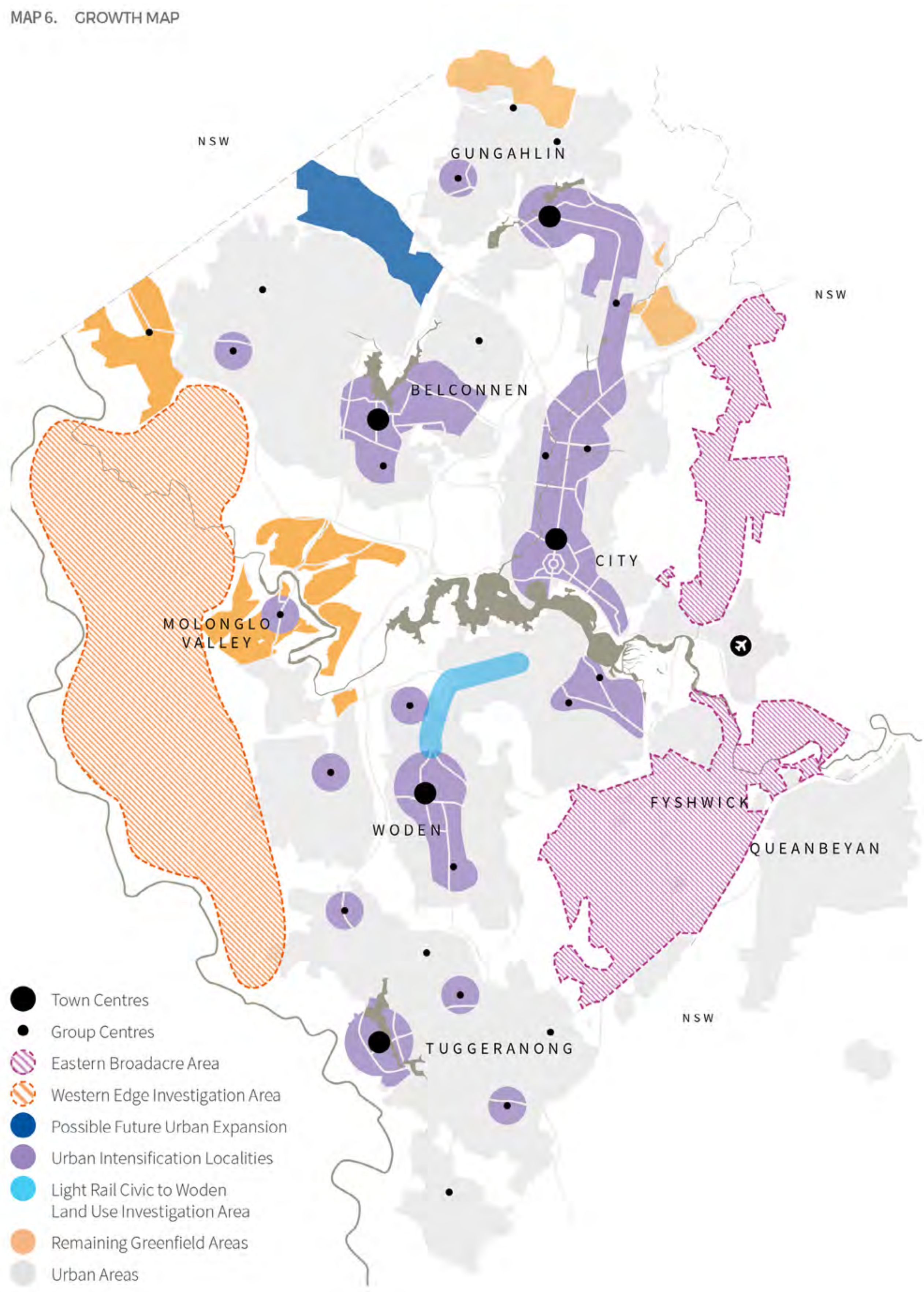



**Figure 12.11.** Current and future urban growth in the ACT.

**Source:** Environment, Planning and Sustainable Development Directorate.

to be translated into policy that informs urban development, and be strictly adhered to throughout the design, planning and construction process.

To better protect aquatic ecosystems, it is important that decisions on the location of new urban areas are better informed by the identified risks to waterways. The site selection for Whitlam in the Molonglo Valley is an example of an urban development that has created significant water quality challenges, which are proving difficult and expensive to mitigate (refer to **Deep Creek case study**). The effective water quality management of the Whitlam development (as well as other areas in the Molonglo Valley) is constrained by the landscape which is steep and highly erodible. This is a significant planning and design challenge. To reduce the environmental impacts of urban development, the ACT needs a strong planning approach, based on clear objectives and enhanced by novel solutions to managing urban runoff. It must be accepted that some sites are not suitable for development due to their soils and topography.

## 12.3 Compliance and enforcement of water protection measures

**Compliance**[285] and enforcement of environmental regulations are critical to reducing impacts on ACT waters and the health and wellbeing of the community. A strong and comprehensive compliance and enforcement culture ensures that harmful behaviours and practices from industry, business and individuals are minimised.

As evidenced above, development and construction practices have a significant impact on receiving waters, including natural rivers, in the ACT. However, it is possible to undertake construction in a way that has less of an adverse effect on water quality, by using appropriately designed and maintained erosion and sediment control measures. Such measures are generally a requirement for a development application to be granted approval (refer to **11.5 Effectiveness of planning decision and development assessment policies and processes**); whether or not these are effectively implemented is however a different matter.

The ACT Environment Protection Authority is responsible for administering legislation and associated regulations which provide for the protection of the environment. The EPA is also responsible for compliance and enforcement activities associated with the protection of the environment, including ACT waters. The EPA has regulatory powers to enforce compliance, including directing businesses to adhere to regulations, and imposing fines for non-compliance. All ACT businesses and community members are required to comply with the EPA's environmental legislation and regulations.

Despite the powers held by the EPA to enable the enforcement of its environmental protection responsibilities, the perception of many stakeholders consulted for this report is that the EPA has a largely tolerant approach to non-compliant behaviours. Many stakeholders, including government and community groups, perceive there is a lack of enforcement for a range of water impacts,[286,287]

285. Compliance is the adherence to legal requirements and obligations of acts and regulations. Enforcement is the use statutory powers under Acts and regulations to achieve compliance.
286. Thukten, 2019. *Water Quality Management Issues in the ACT Waterways: from the experts' perspective*. Prepared for ACT Conservation Council.
287. ACT Auditor-General 2018. *Acceptance of Stormwater Assets*. ACT Government, Canberra.

especially erosion and sedimentation issues from construction of new urban developments. According to stakeholders, such issues are often reported to the EPA, including by those undertaking water quality monitoring activities, with reported issues accompanied by photos and accurate location data for the source of sedimentation. Stakeholders report that even with such evidence, little, if any, action is undertaken by the EPA (refer to **Deep Creek case study** for an example of this).

Data on annual EPA water related compliance and enforcement activities (Table 12.1) supports the perception of the lack of enforcement for activities causing environmental damage.[288] Between 2018–19 and 2020–21, there were only 10 infringement notices for impacts on waterways, only three of which were for non-compliance with erosion and sediment control. The total fines for impacts on waterways amounted to $7725, with only $2625 in fines for non-compliance with erosion and sediment control. This is despite over 221 complaints received (an underestimate, given only complaints received by Access Canberra are reported here), and 4404 inspections of development sites for erosion and sediment control plans. In comparison, the NSW EPA and local councils issued fines amounting to $1,342,500 in 2019–20 for non-compliance with water regulations.[289] Of course the comparative size of NSW, its population and geography, mean that a direct comparison between the ACT and NSW is not possible. However, the water related fines issued in NSW do imply a higher willingness and capacity to issue penalties for non-compliance compared to the ACT.

### Table 12.1. ACT Environmental Protection Authority compliance and enforcement activities and fines for water related infringements, 2018–19 to 2020–21.

| Activity | 2018–19 | 2019-20 | 2020–21 |
|---|---|---|---|
| Number of inspections of development sites for erosion and sediment control plans[A] | 1752 | 1426 | 1226 |
| Public complaints about waterways pollution[B] | 89 | 83 | 49 |
| Number of infringement notices relating to water pollution | 2 | 5 | 3 |
| Fines for pollution of a waterway | $1875 | $1750 | $875 |
| Fines for waste from building site entering waterway | 0 | $600 | 0 |
| Fines for non-compliance with erosion and sediment control | 0 | $875 | $1,750 |
| **Total fines** | **$1875** | **$3225** | **$2625** |

**A:** The EPA must endorse erosion and sediment control plans prior to any land development or other works commencing.

**B:** Only includes complaints received by the Complaints Management Team within Access Canberra, not directly to the EPA or other organisations

288. Chief Minister, Treasury and Economic Development Directorate, 2021. *Annual Report 2020-21, Volume 1, Chief Minister, Treasury and Economic Development Directorate*. ACT Government, Canberra.
289. NSW Environment Protection Authority, 2020. *NSW Environment Protection Authority Annual Report 2019–20*. NSW Environment Protection Authority, Parramatta.

The EPA's approach to compliance with water protection legislation is set out in the Access Canberra *Accountability Commitment, in particular the Accountability Commitment Policy - Regulatory compliance and enforcement*[290] and the *Building and construction services compliance framework.*[291] These documents are endorsed by Cabinet and explain how Access Canberra makes regulatory decisions and approaches its role as both a service provider and a risk-based regulator. The commitment and supporting compliance frameworks detail what factors will be considered when dealing with non-compliance, following the model of engage, educate and enforce.

This engagement-based approach is also reflected in Priority Project 7 in the *Water Sensitive Urban Design Review 2014*, which includes working with the construction industry to improve their performance in erosion and sediment control during the building construction phase, and investigating building certifiers to ensure compliance with site management requirements, including erosion and sediment control. The 2017–18 *Annual Report*[292] for the *ACT and Region Catchment Strategy* and *ACT Water Strategy Report Card for Implementation Plan One (2014–18)*[293] shows that engagement with builders and developers has begun, demonstration sites have been identified to showcase best practice erosion and sediment control methods, and a training video for construction workers on sediment and erosion control was in development. However, it is unclear from *Implementation Plan Two*[294] of the *ACT Water Strategy* how the various elements of the Priority Project 7 and underlying recommendations are being addressed. A two-day training session on sediment and erosion control for construction industry workers organised by the ACT Government as part of the H2OK program in 2019 had very low attendance by industry, indicating that education and self-regulation is not sufficient as a means to address poor sediment control practices on construction sites in the ACT.

A purely education-based approach has not been effective in protecting water quality, with widespread evidence of erosion and sedimentation impacts on waterways, particularly in new urban development areas (see above). Non-compliance with erosion and sediment controls, and the failure of erosion control measures, are impacting on the health of both the Lower Molonglo and Murrumbidgee Rivers. This is despite the responsibility of developers to comply with environmental legislation and regulations and prevent such environmental harm.

Lessons from the NSW *Get the Site Right* campaign — which observed an increase in compliance following significantly heightened enforcement efforts by council and EPA officers[295] — may be applied to the ACT.

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290. Access Canberra, 2020. *Accountability Commitment Policy - Regulatory compliance and enforcement.* ACT Government, Canberra.
291. Access Canberra, 2020. *Building and construction services compliance framework*. ACT Government, Canberra.
292. Environment, Planning and Sustainable Directorate, 2018. *ACT and Region Catchment Management Coordination Group Annual Report 2017-18*. ACT Government, Canberra.
293. Environment, Planning and Sustainable Development Directorate, 2017. *ACT Water Strategy Report Card for Implementation Plan One (2014 - 2018)*. ACT Government, Canberra.
294. Environment, Planning and Sustainable Development Directorate, 2019. *ACT Water Strategy Striking the Balance 2014-44 Implementation Plan Two (2019-23)*. ACT Government, Canberra.
295. NSW EPA, 2020. *Good news for local waterways as builders and renovators Get the Site Right.* https://www.epa.nsw.gov.au/news/media-releases/2020/epamedia200827-good-news-for-local-waterways-as-builders-and-renovators-get-the-site-right

In summary, a lack of compliance with erosion and sediment controls during land development is likely to be posing a significant threat to urban lakes, ponds and waterways in the ACT. To protect the ACT's waterways, the EPA must use the full extent of its legislated powers.

## 12.4 New Queanbeyan Sewage Treatment Plant and operating licence conditions

The population of Queanbeyan is expected to increase along with that of the ACT. This has implications for ACT water quality because any urban development needed for increased housing is within the catchment of the Molonglo River and Lake Burley Griffin. Consequently, the urban development issues for the ACT will also apply to the Queanbeyan area. It is also important to note that Queanbeyan's growing population will lead to higher volumes of treated effluent discharges from the Queanbeyan Sewage Treatment Plant (QSTP).

The planned upgrade of the plant directly affects water quality in Lake Burley Griffin. Historically, discharges from the QSTP have played a significant role in water quality and the eutrophic state of Lake Burley Griffin. The current proposed upgrade is necessary as the existing plant has exceeded its designed life expectancy and there are emerging risks of failure with potentially catastrophic consequences. In addition, the current plant was designed to treat sewage from a population of 35,000 people but is currently operating with a population of 52,000. A proposed new plant will have capacity to treat sewage from 75,000 people.

Compared to the current QSTP, the new plant will have better capacity to manage overflows during storm events, which are predicted to occur more frequently under climate change scenario modelling. It will also have increased capacity on a number of treatment measures, as well as introducing treatment steps which are missing from the current plant. These include a treatment stream like that used to treat drinking water, with a dissolved air flotation filter to remove particles and bacteria of a very small size, and a UV disinfection system to kill any microorganisms that remain in the effluent.

While the proposed new QSTP is clearly needed and will have the capacity to manage sewage from Queanbeyan to a much higher standard than the existing plant, a number of concerns remain about the commissioning of the new plant. Information about the design of the new plant and its environmental impacts have been made publicly available through a Draft Environmental Impact Statement.[296] Numerous concerns have been raised through this process about the downstream water quality consequences associated with the upgraded QSTP.[297] These have included concerns that the new plant will not provide any improvement in water quality and that there are substantial risks to the downstream receiving waters (including Lake Burley Griffin) because of potential reductions in water quality. Concerns were also raised that there has been insufficient data analysis and predictive modelling undertaken to adequately assess the environmental impacts of the upgraded QSTP. This should be undertaken so that the implications of the plant are fully understood. Given the importance of Lake Burley Griffin as a

296. Queanbeyan-Palerang Regional Council, 2020. *Queanbeyan Sewage Treatment Plant Upgrade Environmental Impact Statement Part 1*. Queanbeyan-Palerang Regional Council, Queanbeyan.
297. Environment, Planning and Sustainable Development Directorate. *Queanbeyan Sewage Treatment Plant Upgrade in Jerrabomberra*. ACT Government, Canberra.

centrepiece for Canberra, and the recreational value placed upon the lake, it is well worth additional investment to better understand the effects of the upgraded QSTP.

A key concern with the new treatment plant is not the plant itself but the licensing conditions it will be operating under, which are issued and regulated by the ACT Environment Protection Authority (EPA). The ACT EPA does not require the new QSTP to operate at a significantly higher standard than the current plant. This means that although the new QSTP will be capable of producing much cleaner effluent than the existing plant, there is no legal requirement for it to do so.

- The current discharge licence[298] permits 0.2mg/L of phosphorus in treated effluent. The new plant is designed to produce 0.1mg/L of phosphorus[299] and may operate below this level.
- The current discharge licence permits 30mg/L of nitrogen in treated effluent. The new plant is designed to operate at 5mg/L of nitrogen.
- Notably, in the *Environment Impact Statement Volume 1 Part 1*[300] Table 2.6 shows that the new plant will aim for a nitrogen level of 15mg/L, consistent with the performance of the old plant it is replacing.
- The plant *will not* provide any improvement in levels of nitrogen pollution even though it is designed to offer a three-fold improvement on the old plant.

The ACT Commissioner for Sustainability and the Environment understands that the Queanbeyan-Palerang Council is currently investigating the possibility of revising the licence to make it more appropriate for the new plant design. However, the application of more stringent licence conditions to ensure the best possible water quality outcomes should be a priority for the operator, regulator and the ACT Government. The capacity of the new plant to produce cleaner effluent would indicate that licence conditions must be stricter in recognition of the new treatment plant capability, as well as the need to protect water quality from a growing Queanbeyan population and future increases in sewage discharge volumes.

Such a major infrastructure upgrade affords a once-in-a-generation opportunity to make significant improvement to the quality of effluent leaving Queanbeyan, and better water quality standards must be insisted upon.

298. Chief Minister Treasury and Economic Development, Environment Protection Authority, 2017. *Environmental Authorisation Under the Environment Protection Act 1997*. ACT Government, Canberra.
299. Queanbeyan-Palerang Regional Council, 2015. *Masterplan for Sewage Treatment*. GHD Pty Ltd.
Plant Upgrade.
300. Queanbeyan-Palerang Regional Council, 2020. *Queanbeyan Sewage Treatment Plant Upgrade*. ARUP.

13

# Conclusions and recommendations

*Spotted Marsh Frog. Source: Damien Esquerre*

Contents

## 13.1 Concluding remarks

This report commenced with an explanation that it is preceded, over many years, by various reports, reviews and investigations of the ACT's waterways. This current evaluation of the State of the Lakes and Waterways in the ACT reveals that many key findings of previous reports[301, 302, 303, 304] are still applicable, in spite of many of the recommendations being marked as complete by ACT Government directorates (see Tables 2.1 to 2.4 in **2.4 Statutory reporting on urban lakes and waterways**). In such cases, where issues previously raised persist, recommendations should be revisited, and further reporting is required.

In addition to re-addressing outstanding recommendations, mechanisms to track progress towards recommendations must be strengthened. For some statutory reports, there is no follow-up process for determining if an implementation plan for the recommendations arising from a report has been prepared or is progressing. This could be achieved through several processes, including that the Legislative Assembly Standing Committee on the Environment, Climate Change and Biodiversity and/or Standing Committee on Public Accounts receive an annual report in the public domain on the current progress of Directorates against previously tabled recommendations.

While addressing these gaps in accountability will move the Territory towards better practice in water management, it must be recognised that urban water management in the ACT is an ongoing challenge. Canberra's lakes and waterways serve multiple, and sometimes, competing roles, including as flood control and prevention, and pollution control and prevention measures, recreation and amenity for communities, and habitat for fauna and flora.

301. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin.* Canberra.
302. Environment and Planning Directorate, 2014. *Water Sensitive Urban Design Review Report.* ACT Government, Canberra.
303. ACT Auditor General, 2018. *Acceptance of Stormwater Assets*. ACT Government, Canberra.
304. Office of the Commissioner for Sustainability and the Environment, 2019. *ACT State of the Environment 2019*. Canberra.

## 13.2 Recommendations to ACT Government

The following Recommendations are to assist the ACT Government to make strategic and practical management decisions to improve water quality outcomes. They are provided in the context of wider water governance reform in the Territory and beyond.

**Recommendation 1.** Re-open water-relevant recommendations of statutory reports and continue to report against these (as identified in Tables 2.1 to 2.4 in **section 2.4** and detailed below):

*Summarised from ACT Auditor-General's 2018 Report on Acceptance of Stormwater Assets*

Recommendation 5. Catchment-wide stormwater planning

EPSDD should identify options for conducting catchment-wide planning, and undertake analysis of stormwater needs, against which future development applications would be assessed. These options should be provided to the Minister for Planning and Land Management for consideration.

OCSE Note: catchment-wide stormwater planning encompasses more than just flood planning and should also consider water quality impacts and the measures that will be needed to mitigate these (see below recommendation).

Recommendation 6. Consideration of stormwater solutions

EPSDD and TCCS, in consultation with the Suburban Land Agency (SLA), should develop a range of stormwater management solutions for new estates and subdivisions, in the context of a catchment-wide plan for the area, to ensure that the optimal solution and the means of financing it are adopted.

Recommendation 10. Development of performance indicators

EPSDD and TCCS should each develop performance measures for the achievement of ACT Government stormwater objectives, including the management of stormwater discharges. These should be publicly reported (for example, in the ACT Water Report).

Recommendation 15. Management of the existing stormwater network

TCCS should:

**a)** develop a preventative maintenance plan for stormwater assets, and

**b)** clearly identify problem areas with, and risks to, the stormwater network.

If required, appropriate remedial action should be recommended to the Minister for Transport and City Services.

Recommendation 16. Reducing damage to accepted assets[305]

A working group (including representatives from TCCS, EPSDD, the SLA, Access Canberra and other relevant entities) should be established to:

**a)** develop a coordinated multi-agency strategy to reduce the damage to accepted assets caused by building and other construction activity, and

**b)** report to the Minister for Planning and Land Management on actions to be taken, then subsequently the results of any actions undertaken.

Recommendation 17. Review and augmentation of existing stormwater infrastructure

TCCS should develop a forward program for the ongoing review of stormwater infrastructure in established areas of Canberra and augmentation of the infrastructure where necessary. The forward program should be provided to the Minister for Transport and City Services for consideration and direction.

*Summarised from OCSE's 2012 Report on the state of the watercourses and catchments for Lake Burley Griffin*

Recommendation 7. Strategic approach to WSUD

The ACT Government should develop a strategic approach to WSUD. This should include:

**a)** Identifying sites where installing catchment intervention, such as wetlands and pollution control ponds, would improve water quality entering urban lakes. This should include identifying WSUD that complement current programs of installing wetlands and water control ponds in both new urban areas and retrofitting in existing suburbs where applicable.

**b)** Ensuring that WSUD requirements are enforced, in particular:

**i.** ensuring that wetlands and ponds are of appropriate sizes to service their catchments, and

**ii.** undertaking auditing/compliance arrangements to ensure that temporary pollution control ponds for sediment control during the construction phase in new estates are maintained and functioning effectively.

**c)** Monitoring the effectiveness of WSUD through improved monitoring following urban developments to determine whether water quality meets WSUD general code targets. Results should be used to inform improvements in WSUD standards.

**d)** Comparison of ACT approaches to WSUD with those of other Australian urban areas to help ours remain consistent with developing technology and best practice.

305. Accepted assets correspond to infrastructure that has been officially handed over from a private entity to the ACT Government. In this way, stormwater infrastructure built as part of new developments by private entities, becomes the responsibility of ACT Government once construction is complete.

**e)** Reviewing the efficacy of existing GPTs. The review should include:

  **i.** effectiveness in pollutant reduction

  **ii.** effectiveness of current maintenance of pollution control measures

  **iii.** capital costs

  **iv.** ongoing maintenance costs to ensure the current drainage infrastructure remains high-standard and is in line with current best practice, protecting downstream environments

  **v.** reduction of polluted leachate water, and

  **vi.** the capacity to manage requirements of future urban growth and development.

**f)** working with the NCA and NSW Councils in the catchment to coordinate a strategic approach across the catchment.

Recommendation 13. QSTP Environmental Authorisation update

The ACT Environment Protection Authority (EPA) review and update the Environmental Authorisation number 0417 for sewage treatment within the Queanbeyan City Council Sewage Treatment Plant to ensure that the treatment process results in discharge quality that matches contemporary best practise for a modern, urban sewerage treatment plant. In line with this, the QCCSTWP should continually review and improve its mitigating practises for inundation and washout events at the treatment plant.

**Recommendation 2.** Publish an annual detailed breakdown of how the Water Abstraction Charge revenue is expended.

*Data, monitoring and reporting of urban lakes and waterways*

**Recommendation 3.** Institute a long-term monitoring and reporting program (in addition to the invaluable information provided by Waterwatch), to comprehensively assess urban water quality, ecological condition, recreation and aesthetic values, management effectiveness, and the impacts of new suburb developments on water quality.

This program should include:

- a review of urban water data collected and held across the ACT Government to identify data gaps, quality issues and data accessibility
- the development of methodologies for assessing waterway condition against published urban water management outcomes, objectives and targets
- the development of clear and consistent ecological condition standards, targets and indicators for urban waters to enable assessment of ecosystem health and management effectiveness. This should include all ponds, lakes, creeks and other running waters
- strategies for improving collaboration and coordination across government and community urban water monitoring programs, and
- provide adequate resourcing to maintain parallel monitoring undertaken by Waterwatch.

**Recommendation 4.** Establish and maintain a single point of truth for water quality in the ACT on a public online platform.

This should:

- incorporate water quality monitoring data from all currently available sources including ACT Government, the NCA, universities (where accessible) and Waterwatch
- include lake and river closure information, and pollution and blue-green algae reporting, and
- provide the location of the recreational water quality report and the reporting framework for the assessment of aquatic ecosystem health and water quality described in Recommendations 28 and 29 in the *2019 ACT State of the Environment Report*.

*Incorporating Ngunnawal Knowledge into care of urban lakes and waterways*

**Recommendation 5.** Formally recognise the cultural value of water held by the Ngunnawal people and further incorporate Ngunnawal practices into management of urban lakes and waterways.

*On-ground management of urban lakes and waterways*

**Recommendation 6.** Fund improvement of the performance of water quality control infrastructure, including through:

- maintenance of existing ponds, wetlands and gross pollutant traps
- supporting activities for water quality (e.g. expanded street sweeping, appropriate disposal of organic matter and application of fertilisers in public places), and
- design and build new water quality control infrastructure in accordance with sub-catchment plans developed as part of Recommendation 7.

*Management or governance of urban lakes and waterways*

**Recommendation 7.** Implement a consolidated management framework for the urban waterways of the ACT.

This should:

- take a catchment or sub-catchment approach, explicitly recognising the inter-connectedness of urban waterways, ponds and lakes, and their catchments
- incorporate and enhance existing management planning and strategy documents, resolving inconsistencies and ensuring that objectives for urban waterway management are clearly defined
- involve Ngunnawal community in water management planning and practice, and
- deal with management of both water flow and water quality.

**Recommendation 8.** Take responsibility for monitoring and management of water quality in Lake Burley Griffin, in recognition of the fact that the ACT Government is primarily responsible for management of the lake's catchment.

**Recommendation 9.** Strengthen community participation in water management through measures such as:

- providing secure, ongoing funding to community groups working on catchment management, water quality testing, ecological surveys and public education and engagement
- expanding the use of deliberative democracy, and
- establishing a formal mechanism for meaningful community involvement in the governance of the proposed Office of Water.

**Recommendation 10.** Reform the Environmental Protection Authority's (EPA) approach to monitoring, compliance and enforcement relating to urban water conditions to re-focus on its core function of protecting the environment, including that the EPA:

- is sufficiently empowered and resourced to undertake compliance monitoring and enforcement of all environmental conditions and activities, including around erosion and sediment controls, and
- monitor the effectiveness and compliance of water pollution control structures for new developments, including during the construction phase, to reduce stormwater impacts on lakes and rivers[306]

*Mitigating emerging issues for urban lakes and waterways*

**Recommendation 11.** Ensure that all new water-related policies, plans and strategies are underpinned by future climate change projections for the ACT.

**Recommendation 12.** Reform the approach to urban planning and future land development to ensure that stormwater management is preventative and proactive rather than remedial and reactive.

This should include:

- accepting that development should not occur in areas where analysis of soils, geology, hydrology and topography indicate that construction of water quality control infrastructure sufficient to preserve environmental targets would be practically or financially impossible, and
- focusing on sedimentation prevention, enforcement and compliance in development and construction, rather than resourcing urban water treatment assets, such as wetlands.

306. Improved monitoring of developments was listed as a priority action in the Lake Burley Griffin Task Force, 2012, *Lake Burley Griffin Action Plan: A Healthier, Better Functioning Lake by 2030*. ACT Government, Canberra.

# Appendices

## Appendix 1: Investigation scope and terms of reference

### Scope

The investigation area includes Lake Burley Griffin, Lake Ginninderra and Lake Tuggeranong, as well as waterways that flow through the urban area and into the Murrumbidgee River, including urban ponds and wetlands and the Molonglo River and tributaries.

This excludes waterways and wetlands that do not flow through the urban area – e.g. those in parks and reserves, water supply catchments etc. and drinking water reservoirs.

### Aims

The main aims of the investigation are to:

- Understand the quality and ecological health of our aquatic ecosystems and the impacts that the urban environment and land development have on receiving waters;
- Review existing policies and practices relating to waterway health; and
- Identify actions for Government and the community to improve water quality and catchment health.

### Content

The investigation will evaluate and provide recommendations to the Minister for the Environment on the following topics.

1. The condition of Canberra's main lakes and waterways and trends in recreational and environmental water quality and ecological condition and function.

2. The effectiveness of key ACT Government management actions and strategies to protect Canberra's lakes and waterways, identifying any gaps or issues to be addressed.

3. The ACT Government's monitoring, evaluation and reporting processes relevant to Canberra's lakes and waterways, identifying any gaps or issues to be addressed.

4. The role of community and stakeholders in managing water quality and ecological health, identifying any gaps or issues to be addressed.

These four themes are outlined in further detail below.

1. Condition of Canberra's main lakes and waterways

   - Examine the changing condition of lakes and waterways in response to the major threats (e.g. climate change and urban development).
   - Consider issues such as:
     - water quality — nutrients, erosion and sediment, other pollutants etc
     - habitat condition – riparian zone, instream habitat quality and diversity, impacts of bedload sediments and turbidity from urban and urban development runoff
     - recreational water quality indicators (where relevant) such as levels of enterococci and blue-green algae and waterway closures to primary recreation
     - receiving waters and issues caused by flows into the ACT from NSW.
   - Provide advice on sites of potential concern where effects are anticipated but not clearly understood or managed. For example, sewerage treatment plants, current and future developments, urban runoff infrastructure or playing fields.
   - Provide recommendations and suggested timeframes.

2. Key management actions and strategies

   - Evaluate the effectiveness of plans and policies for lake and waterway protection and the effectiveness, including cost effectiveness, of Water Sensitive Urban Design measures.
   - Evaluate policy and processes relevant to water quality impacts of planning decisions and development assessments.
   - Evaluate the effectiveness of measures to protect waterways (and riparian zones) via compliance and management activities and the regulation of polluting entities.
   - Identify opportunities for improved governance arrangements to support effective protection and management of waterways, water quality and ecological health in the ACT.
   - Provide recommendations and suggested timeframes.

3. Monitoring, evaluation and reporting processes

   - Comment on current monitoring, evaluation and reporting processes and any gaps to be addressed. Consider whether there may be a need for:
     - a core set of indicators for assessments in addition into the SoE report;
     - selection of key sites across the ACT to measure changes in aquatic health;
     - the role of citizen science (such as Waterwatch and the Catchment Health Indicator Program — noting that these programs have engagement value as well as monitoring outcomes); and
     - existing or recommended processes for reporting to government on trends and recommended mitigation.
   - Provide recommendations and suggested timeframes.

4. The role of the community in protecting lakes and waterways

- Identify cultural and recreational issues of relevance.
- Evaluate whether the current governance arrangements allow stakeholders to develop a shared vision for water quality and ecological health in the ACT.
- Comment on the capacity of key stakeholders (including the community) to assist with management decisions and implementation activities.
- Provide recommendations and suggested timeframes.

## Appendix 2: Main findings from the 2012 State of the Watercourses and Catchments for Lake Burley Griffin

The 2012 OCSE Investigation into the state of Lake Burley Griffin provided a comprehensive assessment of the lake and associated watercourses.[307] The Investigation also provided 17 recommendations to improve the health and management of Lake Burley Griffin.

The main findings from the 2012 report include:

**Water quality and environmental condition**

- The water quality in Lake Burley Griffin reflects the composition and amounts of pollutant loads from the rivers, creeks and drainages that enter the lake from its sub-catchments, as well as the biological, chemical, and physical processes that occur within the lake.
- Urban areas have the greatest impact on the water quality in all lakes in Canberra through the transport of organic matter and animal wastes into waterways.
- Runoff from urban areas is identified as a major cause of blue-green algae blooms in the lake.
- The main threats to Lake Burley Griffin's values were high concentrations of blue–green algae and faecal contamination.
- The primary factors driving the blooms of blue–green algae is the release of phosphorus from sediments, when dissolved oxygen concentrations are low and there is poor mixing of the water column, particularly during dry periods.[308]
- Poor water quality was found to impact on the values of Lake Burley Griffin, including:
    - the health of aquatic organisms
    - loss of submerged and emergent water plants
    - health risks to sporting and recreational users
    - loss of amenity because of lake closures
    - scenic and aesthetic impacts of turbid water and blue-green algae scums and odours
    - economic consequences for businesses serving the needs of lake users.
- Main pollution sources include:
    - organic matter loading in urban stormwater
    - increasing urbanisation contributing more organic material to the lake
    - main sources of faecal pollution were urban runoff, animal faeces, regrowth of bacteria already present in the lake, and possible leakages from ageing sewer pipes
    - the Queanbeyan City Council Sewage Treatment Plant was not found to be a significant source of faecal pollution in the lake except when infrastructure failures or overflows occurred
- The potential for discharges from the Queanbeyan City Council Sewage Treatment Plant to stimulate algal growth was reduced by low phosphorus and high nitrate concentrations.[309]

307. Office of the Commissioner for Sustainability and the Environment, 2012. *Report on the State of the Watercourses and Catchments for Lake Burley Griffin*. Canberra.
308. Note: assessments undertaken for this report show that blue-green algal blooms also occur during wet periods.
309. Note: current knowledge suggests that high nitrogen levels do not limit the growth of blue-green algae.

**Catchment management**

- No single treatment is available to address all the causes of poor water quality, and in particular, the key threats of blue-green algae and bacteria in Lake Burley Griffin.
- Problems are the result of complex, and in some cases, long-standing practices.
- The overall management of the catchments and the lake itself is separated across the governments of Commonwealth, ACT and NSW with improved coordination and consultation required.
- Despite the widespread acceptance of the importance of integrated catchment management, no such agreement is in place for the Lake Burley Griffin catchment.
- There is no shared vision or clear and integrated agreement on values and strategies for achieving integrated catchment management, and consequently, no mechanism to prioritise actions, guide discussion or establish a shared vision for the lake among the residents, businesses, and governments that use and manage the lake's catchment.
- Identified options for improving water quality in Lake Burley Griffin and other urban lakes and ponds in the ACT, included:
  - restoration of large in-water plant (macrophyte) systems to restore oxygen levels and intercept pollutants
  - installation of artificial re-aeration systems and/or installation of mechanical mixer systems to distribute oxygen to lower levels of the lake
  - modification of phosphorus cycling in the lake, including sediment treatment, to reduce the availability of phosphorous for algal growth
  - algae farming to remove nutrients, and sonic destruction of algal blooms.
- It was noted that all options require thorough assessment of the environmental, social and economic impacts.
- While water sensitive urban design (WSUD) has been applied in many parts of Canberra's stormwater system, a more strategic approach to WSUD is needed to ensure the most efficient and effective combination of interventions are developed and effectiveness measured.
- The growth in rural residential settlements need to be addressed at a strategic regional level, particularly in relation to the implications for the Lake Burley Griffin catchment.
- Effective management of the Googong Foreshores and Jerrabomberra Wetlands Nature Reserve has the potential to strengthen protection of lake water quality.
- The investigation identified four targets for management interventions directed towards remediation of lake environmental and recreational values:
- urban catchments including the use of (WSUD) to capture and remove pollutants from urban stormwaters
  - rural catchments and residential settlements, including the need to decrease phosphorus, organic matter and suspended solids during wet periods
  - sewage treatment and discharge including regular reviews and improvement of sewerage system management to mitigate some of the potential risk of leakage of partially treated or untreated sewage into the lake, especially during large stormwater events

- improved river flow management, including increasing minimum flows during summer months to reduce the impact of Googong Dam which has decreased flows to and through the lake, increasing nutrient availability and algal blooms.

**Recreational water quality**

- There is a need for much greater understanding across ACT Government agencies of the benefits, costs and opportunities for improving water quality in recreational waterways.
- Decisions about ways to secure acceptable water quality need to recognise the multiple roles performed by urban lakes and ponds, particularly their role in downstream water quality management.
- Decisions also need to consider the environmental, social and economic values that the ACT community places on recreational waterways, as the context for assessing the costs and benefits of any decisions.
- Management and planning of the recreational waterways' catchments needs to be integrated across the responsible ACT government agencies.
- Pollutants must be intercepted at their source and in tributaries upstream of recreational waterways.
- On-site management of the recreational waterways must apply best practice and technological developments in water quality management.

# Appendix 3: Urban ponds and wetlands assessed in this Investigation.

| Name and description |
|---|
| **Banksia Street Wetland**<br>An off-line wetland constructed in 2010 and located within the Sullivans Creek Catchment. Low flows from the concrete stormwater channel are diverted into the wetland. Once the water has made its way through the wetland, it flows into an underground pipe which discharges back into the stormwater channel. From there the water makes it way down the channel eventually discharging into Lake Burley Griffin. The wetland includes two sections — a pond that is approximately 1.4 metres deep in the centre at normal operating level and an ephemeral zone that ranges from 0 to 0.3 m deep. Banksia St is Canberra's first retrofitted urban wetland to incorporate an ephemeral section designed to dry out during summer. |
| **Conder Wetlands**<br>Situated on Conder Creek which arises in the Rob Roy Nature Reserve and flows into Point Hut Pond. |
| **David Street Wetland**<br>An offline pond adjacent to Sullivans Creek in the inner north Canberra suburb of O'Connor. It was constructed in 2001 and is located along the westerly branch of Sullivans Creek which consists of a concrete stormwater channel. The wetland takes water during low flows. Once the water has passed through the wetland, it flows back into the concrete channel just before it joins the main northern branch of Sullivans Creek. The water body occupies an area of around 800 $m^2$. The banks of the pond have been planted with macrophytes. The pond is not intended for swimming or other aquatic activities. |
| **Dickson Wetland**<br>An offline wetland constructed in 2010 and located opposite the main playing fields in Dickson. A large concrete stormwater channel supplies water to the wetland during low flows but during high rainfall events, flows bypass the wetland, remaining in the concrete channel. Water that passes through the wetland flows back into the concrete channel and through to Lyneham Wetland just upstream of the confluence with Sullivans Creek. Excess stormwater is piped to the Dickson Playing Fields and stored in tanks on site for irrigation use. |

| Values | Water quality data source |
|---|---|
| This water body was constructed to:<br><br>› improve water quality by trapping nutrients and sediments, particularly from stormwater flows<br>› contribute to urban biodiversity by providing habitat for water birds, turtles, yabbies, water bugs and frogs from a diverse array of locally occurring aquatic and terrestrial plants, and<br>› provide recreational, educational, and volunteering opportunities for the community. | Waterwatch (2011–14 and 2017–21) |
| Together with Point Hut Pond, Conder Wetlands makes up a stormwater system that reduces flows and includes verge vegetation to reduce negative impacts from suburban runoff. | Waterwatch (2011–2021) |
| This water body was constructed to help improve water quality in Sullivans Creek and provide urban habitat. It aims to:<br><br>› improve water quality, particularly by removing nitrogen and phosphorus from stormwater<br>› provide aquatic and terrestrial habitat for animals<br>› manage stormwater by holding water during high rainfall events, and<br>› provide an attractive outdoor space with a visible water body | Waterwatch (2011–2021) |
| This wetland provides multiple benefits including providing:<br><br>› water quality improvements by reducing excess nutrients and suspended solids<br>› flood detention<br>› aquatic and terrestrial habitat in urban areas<br>› an attractive area associated with a waterbody<br>› new recreational, volunteering and educational opportunities<br>› a supply of stormwater to irrigate playing fields, and<br>› restoration of concrete channels to living systems. | Waterwatch (2013–2021)<br><br>ACT Government Lakes and Rivers Water quality monitoring program (2014–2021) |

| Name and description |
|---|
| **Flemington Pond**<br>Consists of two wetlands constructed in 2009–10 on an ephemeral section of Sullivans Creek. The ponds are downstream of the industrial area of Mitchell where it includes the stormwater channel from Exhibition Park. |
| **Gungaderra Pond**<br>Is located within the Gungaderra Creek reach which starts in the southern suburbs of Gungahlin, flows through the Gungaderra Grassland Reserve and into Ginninderra Creek at Giralang Pond just upstream of Lake Ginninderra. |
| **Gunghalin pond**<br>Constructed in 1989 as part of the Gungahlin Stormwater Pollution Control and Belconnen Flood Protection Strategy. It receives water from the upper section of Ginninderra Creek which mostly comprises ephemeral creeks fragmented by stock dams. These reaches also include inflows of urban stormwater from surrounding suburbs and new developing suburbs. The pond has extensive open water areas, with limited macrophyte zones around their margins. It also has gross pollutant traps installed on the inlets to limit litter discharge. |
| **Isabella Pond**<br>Is the main settlement pond for stormwater entering Lake Tuggeranong from the south western Tuggeranong suburbs. Water passes over a high weir at its western end into Lake Tuggeranong. The pond was constructed in the 1980s. |
| **Jaramalee Pond**<br>Constructed in 1994. Little background information is available on this pond. |

| Values | Water quality data source |
|---|---|
| Flemington Pond aims to:<br><br>› increase supplies of non-potable water to save about 600,000 kilolitres of potable water per annum, and provide a diversified fit for purpose water source at a cheaper cost to end users<br>› improve water quality in Sullivans Creek<br>› reduce peak flood flows, and<br>› create habitat and improve the aesthetic appeal of the site. | Waterwatch (2011–2021)<br><br>ACT Government Lakes and Rivers Water quality monitoring program (2011–2021) |
| Unknown | Waterwatch (2011–2021) |
| Gungahlin pond has been designed to:<br><br>› limit pollutant loading on Lake Ginninderra by trapping nitrogen, phosphorus and sediments<br>› improve the aesthetic character of the area<br>› provide recreational, opportunities for the community, and<br>› provide flood attenuation, reducing peak stormwater flows. | Waterwatch (2011–2021)<br><br>ACT Government Lakes and Rivers Water quality monitoring program (2011–2021) |
| Unknown | Waterwatch (2012–2021) |
| Unknown | Waterwatch (2011–2021) |

| Name and description |
|---|
| **Lyneham Wetlands**<br>An online wetland constructed in 2012 which takes all runoff, including high flows following storms. Urban stormwater from Dickson, Downer, Hackett and Watson flows to Lyneham Wetland through the stormwater network of concrete pipes and channels. Lyneham Wetland overflows into Sullivans Creek when water levels are sufficiently high. |
| **North Watson Wetlands (Billabong Park)**<br>Located on the lower western slopes of Mount Majura nature reserve. They comprise a drainage line with two dams. Further down, a small constructed wetland receives runoff from the adjacent suburb, and a small wetland soak takes overflows at the bottom of the reach. The water then flows via pipes into Sullivans Creek. |
| **Point Hut Pond**<br>A sediment control pond constructed in the 1980s in the suburb of Gordon. Together with the Conder Wetlands, the pond makes up a stormwater system that has been engineered to reduce flows. The pond incorporates verge vegetation to reduce the negative impacts from urban runoff. The water from this system flows into the Murrumbidgee River just downstream of Point Hut Crossing. |
| **Stranger Pond**<br>Constructed in the 1980s, this system consists of Upper Stranger and Lower Stranger Ponds connected by a tapped pipe (normally closed) under Drakeford Drive. The whole system is immediately to the south of Lake Tuggeranong and provides storm water treatment for the suburb of Bonython. |

| Values | Water quality data source |
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| This wetland provides multiple benefits including:<br><br>› water quality improvements by reducing excess nutrients and suspended solids<br>› flood attenuation<br>› the provision of aquatic and terrestrial habitat in urban areas<br>› the provision of an attractive area associated with a waterbody<br>› new recreational, volunteering and educational opportunities<br>› a supply of stormwater to irrigate playing fields, and<br>› restoration of concrete channels to living systems. | Waterwatch (2014–2021)<br><br>ACT Government Lakes and Rivers Water quality monitoring program (2014–2021) |
| Unknown | Waterwatch (2011–2016 and 2018–2021) |
| Specific values have been identified with Point Hut Pond including:<br><br>› water quality improvements by reducing excess nutrients and suspended solids<br>› flood detention<br>› the provision of aquatic and terrestrial habitat in urban areas<br>› the provision of an attractive area associated with a waterbody<br>› recreational fishing opportunities<br>› informal recreational opportunities which people associate with lakes and ponds, and<br>› a limited range of facilities which cater for competitive water sports. | Waterwatch (2011–2021)<br><br>ACT Government Lakes and Rivers Water quality monitoring program (2011–2021) |
| Unknown | Waterwatch (2012–2021) |

| Name and description |
|---|
| **Valley Ponds**<br>Originally an old farm dam and artificial seepage grassland, the Valley Ponds was a unique habitat within the Ginninderra catchment. The site was redeveloped into an urban wetland in 2012 for the Gungahlin town centre and parts of Palmerston. It is now a high-quality education and recreational wetland featuring walking paths, an outdoor classroom and boardwalk, rock jetties and interpretive signage. |
| **Yerrabi pond**<br>Constructed in 1994 as part of the Gungahlin Stormwater Pollution Control and Belconnen Flood Protection Strategy. It is formed by the Mirrabei Drive embankment across East Ginninderra Creek. The pond receives moderate inflows from stormwater from the surrounding suburbs. It has extensive open water areas, with limited macrophyte zones around the margins. It also has gross pollutant traps installed on the inlets to limit litter discharge. |

| Values | Water quality data source |
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| This wetland provides multiple benefits including:<br><br>› improving stormwater quality before it reaches Ginninderra Creek<br>› flood detention, attenuating flows from the Gungahlin town centre<br>› contributing to urban biodiversity by providing aquatic and terrestrial habitat in urban areas, and<br>› supplying stormwater to irrigate playing fields. | Waterwatch (2011, 2014–2015, 2017–2021) |
| Yerrabi pond has been designed to:<br><br>› limit pollutant loading on Lake Ginninderra by trapping nitrogen, phosphorus and sediments<br>› improve the aesthetic character of the area<br>› provide recreational, opportunities for the community, and<br>› provide flood attenuation by reducing peak stormwater flows and substantial temporary stormwater storage during periods of high rainfall. | Waterwatch (2011-2021)<br><br>ACT Government Lakes and Rivers Water quality monitoring program (2011–2021) |

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