Shane Rattenbury MLA - Arrangements brief

FUNCTION:	Launch of the 2022 Waterwatch Catchment Health Indicator Program (CHIP) report A copy of the report is at Attachment D.
VENUE:	Dickson Wetland, Dickson. See map at Attachment A.
HOST:	Name: Woo O'Reilly Mobile: Personal Information
DAY:	Wednesday
DATE:	22 March 2023
TIME:	8:30am
TIME COMMITMENT:	30 minutes
CATERING:	Yes – coffee and pastries will be provided
DRESS CODE:	Casual
YOUR ROLE:	A short speech to launch the CHIP report. Speaking notes in Attachment B.
WHERE TO PARK:	Off Hawdon St, Dickson
WHO WILL MEET YOU:	• Bren Burkevics (Executive Group Manager, Environment, Heritage and Water Division, EPSDD) • Woo O'Reilly (Regional Waterwatch Facilitator, EPSDD)
ADVISOR ATTENDING:	Lachlan Roberts/ Anna McGuire (TBC with your office).
AUDIENCE:	Waterwatch volunteers as well as the broader Waterwatch network. This includes members of the three community-based Catchment Groups (Molonglo, Ginninderra and Southern ACT) who partner with the ACT Government to implement the program plus water scientist from UC and members of the UMCN committee. Icon Water representatives are also invited.
VIPs:	The following attendees have been invited: • Icon Water officials (who co-fund the Waterwatch program) • Chair of Landcare ACT • Commissioner for Sustainability and the Environment
PAST INVOLVEMENT:	You launched the report 2021 at the Gungahlin Scout Hall.
SENSITIVITIES:	The report briefly mentions issues with sediment runoff and erosion associated with development sites, both within the ACT (lower Molonglo River) and in Queanbeyan. Water quality issues associated with Icon Water operations (such as the Lower Molonglo Water Quality Control Centre) and the Googong Water Recycling Plant are also mentioned.

Shane Rattenbury MLA - Arrangements brief

ORDER OF CEREMONIES	8:30am: Arrive and be greeted by Bren Burkevics and chat with volunteers. 8:40am: Bren Burkevics introduces the Minister. 8:45am: Minister Rattenbury speaks, officially launching the 2022 CHIP report. 8:50am: Bren Burkevics thanks everyone for attending and invites all present to stay for coffee and pastries and look at the waterbugs plus some information displays about the CHIP report. 9:00am: Minister departs.
MEDIA:	Yes, a Media Release is at Attachment C.
SOCIAL MEDIA ACCOUNTS	**Facebook**: ACT Landcare and Waterwatch @ACTlandwater Southern ACT Catchment Group @SACTCG Ginninderra Catchment Group @GinninderraCatchmentGroup Molonglo Conservation Group @Molonglo Conservation **Twitter:** @ACTlandwater
OUTSTANDING REGULATORY ISSUES	Nil.

ATTACHMENT A – DICKSON WETLANDS (parking off Hawdon St)

Shane Rattenbury MLA

SPEAKING NOTES

Launch of the Waterwatch Catchment Health Indicator Program (CHIP) report 2022.
8:30am, WEDNESDAY, 22 MARCH 2022
Dickson Wetlands, Dickson

Acknowledgements

- I acknowledge the traditional custodians of the land we are meeting on, the Ngunnawal people. I also acknowledge the Ngarigo people as the report we are launching today covers the entire upper Murrumbidgee catchment which includes their traditional lands in the Cooma Monaro region. We acknowledge and respect their continuing culture and the contribution these custodians make to the life of the ACT and the broader region.
- I would like to thank you all for coming here today to celebrate World Water Day and acknowledge the great achievement that is the Waterwatch 2022 Catchment Health Indicator Program report – known to most as the CHIP report.
- I welcome representatives from Icon Water who continue to support Waterwatch in the southern end of the catchment in the Cooma Monaro region. Their funding over the past 12 years has ensured that the CHIP report can provide a regional picture of the health of our waterways.
- And of course, a very warm welcome to the fantastic Waterwatch volunteers who have joined us today. I look forward to thanking you all over a coffee and discussing what another wet year we had. There was certainly plenty of water to watch! An impressive 1,992 water quality surveys were conducted forming the central part of the 2022 CHIP report!

Upper Murrumbidgee Waterwatch

Shane Rattenbury MLA - Arrangements brief

- Upper Murrumbidgee Waterwatch supports the community in the monitoring and caring of our local waterways. There are currently 237 active sites located from right at the top of the Murrumbidgee River in Kosciusko National Park, all the way down to Taemas Bridge where the Murrumbidgee enters Burrinjuck Dam near Yass. This covers an area of over 11,400km^2.
- The first Waterwatch water quality sample in the ACT was taken at the Tidbinbilla River in 1995. And just this very month on the Atlas of Living Australia, the Waterwatch database received its **30,000th record!**
- While water quality data makes up the bulk of the Waterwatch data (27,345 surveys to be exact), information on the condition of the riverbank vegetation and waterbugs are also collected. I see we have some waterbugs on display here today from the wetlands as well as some information on the CHIP report, so I encourage you to browse the displays with your coffee and pastries and learn about the life in our waterways.

CHIP

- The purpose of the CHIP report is to give the community a better understanding of water quality and waterway health issues in the catchment as well as providing a baseline assessment of catchment health to assist natural resource managers and policy-makers.
- The 2022 CHIP report results are impressive:
    - 97 report cards on various river and wetland reaches across the ACT region;
    - 1,992 water quality surveys, 192 waterbug surveys and 232 riverbank condition assessments; and
    - All by over 200 Waterwatch volunteers.

- The results show that:
    - 52 report cards received an Excellent (A) or a Good (B) result:
    - 44 scored a Fair (C); and
    - Only 1 received a Poor (D) result.
- This is the highest number of 'Excellent' and 'Good' ratings recorded in the nine years the CHIP has been produced in its current format and broke the previous record set in 2021.

Condition of Waterways in 2022

- Like the previous year, 2022 was wet! La Niña conditions persisted for a third consecutive year, with rain falling on already saturated landscapes. As a result, increased runoff and high energy flows in our waterways became commonplace, particularly in late Winter and Spring.
- The high flows had a flushing effect on our rivers, improving dissolved oxygen levels and diluting salts and minerals. This produced overall positive results for water quality.
- The frequency of the high-energy flows, however, left certain urban and rural waterways vulnerable to erosion and scouring due to a lack of intact, native vegetation, both in-stream and along the riparian zone. This highlights the need to restore the structural integrity of our waterways as this will make them more resilient to extreme weather conditions.

Acknowledging Waterwatch

- The Upper Murrumbidgee Waterwatch program is held up as a model citizen science program, collecting quality data that is used for a range of catchment

management purposes. One of the many examples is a report titled 'State of the Lakes and Waterways in the ACT' that was released in 2022 by the Office for the Commissioner for Sustainability and the Environment. They had this to say about Waterwatch:

- ***'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'.***
- So on that positive note, it is now my pleasure to officially release the Waterwatch 2022 Catchment Health Indicator Program report. I thank you again for all that you do to protect our waterways.

ENDS

ACT Government

Media release

Shane Rattenbury MLA

Attorney-General
Minister for Consumer Affairs
Minister for Water, Energy and Emissions Reduction
Minister for Gaming

Member for Kurrajong

22 March 2023

ACT Region's water quality reaches new heights in latest catchment health report

The latest Catchment Health Indicator Program (CHIP) report shows that water quality across the ACT region has improved, making 2022 the best year in the report's nine-year history.

Minister for Water, Shane Rattenbury said the 2022 CHIP, released today by Upper Murrumbidgee Waterwatch, covers one of the wettest years in recent memory.

"Thanks to La Niña conditions for a third consecutive year, heavy rainfall on the already saturated landscape produced constant runoff and high water flows throughout 2022," Minister Rattenbury said.

"Although the heavy rain and continuous, high flowing water has resulted in our highest water quality scores in recent memory, this has contributed to an increase in streambank erosion across the ACT region, with soil and other materials are washed off the bank and swept away downstream.

"This was especially the case in urban and rural areas with low numbers or diversity of native vegetation, both in-stream and along the riverbanks. This highlights the importance of restoring our urban and rural waterways to protect our native and diverse plant species and making them more resilient to extreme weather conditions.

"Results from the annual Platypus Month surveys were also highlighted in the report, with 21 individual platypus sighted over August 2022. This is 10 less than were recorded during the same period in 2020 and is likely a consequence of high flows disrupting platypus feeding behaviour.

"The CHIP report would not be possible without our volunteers and their continued dedication to collecting crucial data on the health of our waterways."

The 2022 CHIP report is based on the results of 2,000 surveys conducted by over 200 volunteers at 237 sites across the ACT region. Over 30,000 surveys have been conducted since the program began in 1995.

For more information on the Catchment Health Indicator Report or the Platypus Month surveys, visit the Upper Murrumbidgee Waterwatch website.

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Media release

Shane Rattenbury MLA

Attorney-General
Minister for Consumer Affairs
Minister for Water, Energy and Emissions Reduction
Minister for Gaming

Member for Kurrajong

Statement ends

Media contact/s:
Jordan Maloney **M** Personal Information Jordan.Maloney@act.gov.au

WATERWATCH
Upper Murrumbidgee

Catchment Health Indicator Program

2022

Supported by:

ACT Government

icon WATER

In Partnership with:

Molonglo Catchment Group

Southern ACT Catchment Group

Ginninderra Catchment Group

Waterwatch acknowledges the Traditional Custodians of the region, the Ngunnawal and Ngarigo peoples. We recognise and respect the enduring relationship they have with their lands and water, and pay our respects to Elders, past, present and emerging.

Written and produced by the following:

Woo O'Reilly – Waterwatch Regional Facilitator

Antia Brademann – Cooma Region Waterwatch Coordinator

Martin Lind – Southern ACT Waterwatch Coordinator

Bruno Ferronato – Ginninderra and Yass Region Waterwatch Coordinator

Jed Pearson – Molonglo Waterwatch Coordinator

Isobel Booksmythe – Citizen Science Data Analyst

Anke Maria Hoefer - FrogWatch Coordinator

For more information on the Upper Murrumbidgee Waterwatch program go to: http://www.act.waterwatch.org.au

The Atlas of Living Australia provides database support to the Waterwatch program. Find all the local Waterwatch data at: https://biocollect.ala.org.au/actwaterwatch

This document can be cited as: Upper Murrumbidgee Waterwatch (2022) Catchment Health Indicator Program: Report Card 2022. Canberra.

Contents

Executive Summary

Upper Murrumbidgee Waterwatch (Waterwatch) works with the community to monitor, raise awareness, educate, restore and protect our local waterways. Waterwatch has been running in the ACT region since 1995 and covers the Murrumbidgee catchment upstream of Burrinjuck Dam (with the exception of the Goodradigbee catchment). The total area monitored by Waterwatch is more than 11,400km^2.

This is Ngarigo and Ngunnawal country. The headwaters of the upper Murrumbidgee are also the shared responsibility of the Ngarigo, Walgalu and Wiradjuri peoples. Waterwatch acknowledges these Traditional Custodians and recognises and respects the enduring relationship they have with their lands and waters. We pay our respects to Elders, past and present and emerging.

Two primary functions of the Waterwatch program are to facilitate community engagement through the monitoring and care of local waterways, and to use the data (water quality, macroinvertebrate [waterbug] and riparian condition) as an early warning system for aquatic ecosystem health issues. A key output of this program is the annual Catchment Health Indicator Program (CHIP) report, which provides a numerical score of catchment health, displayed in individual reach (sections of waterway) report cards, using data collected by Waterwatch volunteers.

The 2022 CHIP report is based upon 1,992 water quality surveys, 192 waterbug surveys and 232 riparian condition surveys conducted by over 200 volunteers. The total number of sites surveyed was 237 with a total of 97 reach report cards produced. The CHIP report usually includes the number of 'dry' events in the overall survey tally (ie. when a volunteer has visited their site but it is completely dry). While these do not contribute to the CHIP score, they are an important factor in the condition of the catchment and highlight survey effort. As you might expect, no sites were recorded as dry in 2022 but there were a couple of occasions where sites weren't sampled due to conditions being too wet to access them!

Of the 97 reaches presented in this report (Table 1), eight were scored as in *excellent* condition. This is the highest number of *excellent* ratings recorded in the nine years the CHIP has been produced in its current format, breaking the previous record of seven set in 2021. A further 44 reaches were scored as being in *good* condition, two more than last year, and 44 reaches were in *fair* condition, one less than 2021. One reach received a *poor* score, which was one less than last year, and no reaches received a *degraded* score. 2021 saw a marked improvement in catchment condition compared to the dramatic impacts of the fires and drought in the preceding years. While overall condition improved again in 2022, it was less pronounced and not as uniformly felt across all waterways.

Table 1: CHIP results from 2022

CHIP Result	Cooma	Ginninderra	Molonglo	Southern ACT	Yass	Total
Excellent (A)	3	0	1	4	0	8
Good (B)	12	1	14	15	2	44
Fair (C)	8	14	11	7	4	44
Poor (D)	0	0	0	1	0	1
Degraded (E)	0	0	0	0	0	0

Like the previous year, 2022 was wet! La Niña conditions persisted for a third consecutive year, with rain falling on already saturated landscapes. Rivers across the region showed quicker response times in their increase in water levels following rain. As a result, high energy flows became commonplace, particularly in late Winter and Spring. While this constant flushing of rivers over three years has on the whole been positive, it has produced some mixed results this year. The Molonglo and Southern ACT catchments showed clear improvement, due predominantly to greater waterbug diversity and abundance, but also through improved water quality. On the other hand the Cooma Region saw a slight downward trend in condition, also led by said waterbugs. Given over half of Cooma's reaches received an *excellent* score for water quality, it appears that this result was driven in part by high flows flushing waterbugs away with limited opportunity for recruitment before the next flush. This played out in various reaches across the broader catchment with declines in waterbug diversity seen in steeper, upstream reaches such as the upper Queanbeyan River (QUE1) and upper Cotter River (COT1), and in reaches receiving high energy flows downstream of urban areas such as on Ginninderra Creek (GIN5 and GIN6).

It wasn't just the flushing effects of high flows driving diminished waterbug results. High flows and raised water levels can also scour stream channels and submerge the in-stream and edging vegetation that provide important waterbug habitat. There were noted increases in streambank erosion in reaches where in-stream and riparian native vegetation were lacking. This included rural rivers such as the lower Bredbo (BRD2), the lower Numeralla (NUM4) and the Murrumbidgee near Bredbo (CMM5). Small tributaries, including those downstream of new and existing urban development, also fared poorly. The greater amount of impermeable surfaces in these areas can result in flashy and increased flows that impact riparian areas with poor structure. Significant erosion was noted particularly in the lower Molonglo catchment, including Deep, Weston and Yarralumla Creeks plus an unnamed tributary receiving waters from Denman Prospect.

While waterbug results varied considerably across the upper Murrumbidgee catchment, water quality mostly showed improvements. Almost half of all reaches (45) showed increased levels of dissolved oxygen this year, including some urban areas. The increased runoff also helped dilute salts and minerals, keeping electrical conductivity scores down, and despite erosion issues, turbidity readings were generally lower as well. That said, when Waterwatch sampling coincided with a storm event, there was evidence of high phosphorus and turbidity levels, particularly in rural catchments. High nutrient levels also continue to be an issue in urban waterways.

Even though 2021 was a slightly wetter year than 2022, the catchment was still absorbing the rainfall, filling dams and recharging groundwater tables. This year's results have highlighted that once the catchment is saturated, the greater responsiveness of flows to rain events and more frequent high-energy flows, leave certain urban and rural waterways vulnerable to erosion and scouring due to a lack of structural integrity. The question of how riparian vegetation condition has influenced the relationship between annual rainfall and water quality scores led Waterwatch to undertake a long term study using our water quality data and riparian assessments. The results suggest there is a relationship between more simplified riparian condition (such as in urban catchments) and a decrease in water quality after rain. This would make sense as, for example, catchments with poor groundcover have less ability to capture nutrients and sediment from runoff before they enter the waterways. This study provides evidence to better support land managers in restoring waterways with the aim of making them more resilient to extreme weather conditions. More details are available in a special report on page 118.

Platypus Month was back stronger than ever in 2022 with over 300 volunteers braving the Winter chill to lend us a hand. **A total of 21 individual Platypus were detected across the eight 'river reach' sites during Platypus Month 2022.** This is ten fewer than were seen during August 2020. It appears that high flows may be causing issues with detectability and/or creating disruptions to regular Platypus foraging behaviour. One concerning observation was at Jerrabomberra Creek where no Platypus were detected at all. This is the first time this has happened since Waterwatch started regular monitoring there during Platypus Month 2014. A full report of Platypus Month can be seen on page 122.

Thank you, as always, to the volunteers. The CHIP report would not be possible without your continued efforts to collect this important data on the health of our waterways. At the time of writing this report, the **Waterwatch database is housing a nice round number of just over 30,000 records!** The Upper Murrumbidgee Waterwatch program is held up as a model citizen science program, collecting quality data that is used for a range of catchment management purposes. One of the many examples is a report titled '*State of the Lakes and Waterways in the ACT*' that was released in 2022 by the Office for the Commissioner for Sustainability and the Environment. They had this to say about Waterwatch:

'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'.

The 2022 CHIP report would not be possible without the financial support of the ACT Government and Icon Water.

Introduction

Upper Murrumbidgee Waterwatch

Upper Murrumbidgee Waterwatch (Waterwatch) engages with the community to monitor, raise awareness, educate, restore and protect our local waterways. Waterwatch has been running in the ACT region since 1995 and covers the Murrumbidgee catchment upstream of Burrinjuck Dam, with the exception of the Goodradigbee catchment. The total area monitored by Waterwatch is more than 11,400km^2.

This is Ngarigo and Ngunnawal country. The headwaters of the upper Murrumbidgee are also the shared responsibility of the Ngarigo, Walgalu and Wiradjuri peoples. Waterwatch acknowledges these Traditional Custodians and recognises and respects the enduring relationship they have with their lands and water. We pay our respects to Elders, past and present and emerging.

Four Waterwatch coordinators support volunteers in the major sub-catchments of Cooma, Molonglo, Southern ACT, Ginninderra and Yass (see Figure 1). Each of these sub-catchments make up sections I – V of this report.

As at 31 December 2022, Waterwatch had 237 active sites being monitored by over 200 volunteers. Waterwatch thanks the generous funding from the ACT Government as well as funding for the Cooma Region through Icon Water. Local Land Services also supports the program in the Cooma Region. The Atlas of Living Australia provides support through the maintenance of the database used by the Waterwatch program. At the time of writing this report, the database is housing just over 30,000 Waterwatch records.

The purpose of the CHIP

The Waterwatch annual report card is called the Catchment Health Indicator Program (CHIP) and is based upon the data collected by volunteers throughout the preceding year. The purpose of the report is to give the community a better understanding of waterway and riparian health issues in the catchment as well as providing an ongoing baseline assessment of catchment health, to assist natural resource managers and policy-makers in addressing these issues. The CHIP contributes to multiple monitoring programs and reports within the ACT Government and Icon Water.

How does the CHIP work?

Waterwatch volunteers and coordinators collect data relating to water quality, waterbugs (macroinvertebrates), and riverbank (riparian) vegetation. The frequency of this data collection is outlined in Table 2. These data sources provide the basis for a composite CHIP score that encompasses physico-chemical properties of water, in-stream waterbug diversity and abundance, and riparian vegetation condition. When combined for an individual stretch of waterway (a reach), the data gives us a score that indicates the overall health of that reach. This CHIP score is linked with a colour to produce maps of reaches at both an individual and sub-catchment scale. Importantly, each individual reach map is accompanied by a report card written by the local coordinator. This provides further insight into the state of that reach and possible issues influencing the score. Data from other Waterwatch initiatives such as Platypus Month and Carp Love 20°C, as well as from our colleagues at FrogWatch, are also used in these report cards to provide greater context.

Technical details regarding the computation of CHIP scores is provided in Appendix II.

Table 2. Summary of data collected to produce the CHIP.

	Parameter	Frequency	Number of sites
Water Quality	pH	Monthly	All sites
	Electrical Conductivity	Monthly	All sites
	Turbidity	Monthly	All sites
	Phosphorus	Monthly	All sites
	Nitrate	Monthly	All sites
	Dissolved Oxygen	Monthly	All sites
	Water Temperature	Monthly	All sites
Macroinvertebrates	SIGNAL 2.0	Biannual (Spring & Autumn)	Key sites (min 1/reach)
Riparian Condition	RARC	Biennial	All sites

Figure 1. Overview of the upper Murrumbidgee River catchment, outlining the five major sub-catchment areas represented in this report as well as the border of the ACT. The Goodradigbee catchment is not included in this report.

2022 CHIP

The 2022 CHIP report is based upon 1,992 water quality surveys, 192 waterbug surveys and 232 riparian condition surveys conducted by over 200 volunteers. The total number of sites surveyed was 237 with a total of 97 reach report cards produced. The CHIP report usually includes the number of 'dry' events in the overall survey tally (ie. when a volunteer has visited their site but it is completely dry). While these do not contribute to the CHIP score, they are an important factor in the condition of the catchment and highlight survey effort. As you might expect, no sites were recorded as dry in 2022 but there were a couple of occasions where sites weren't sampled due to conditions being too wet to access them!

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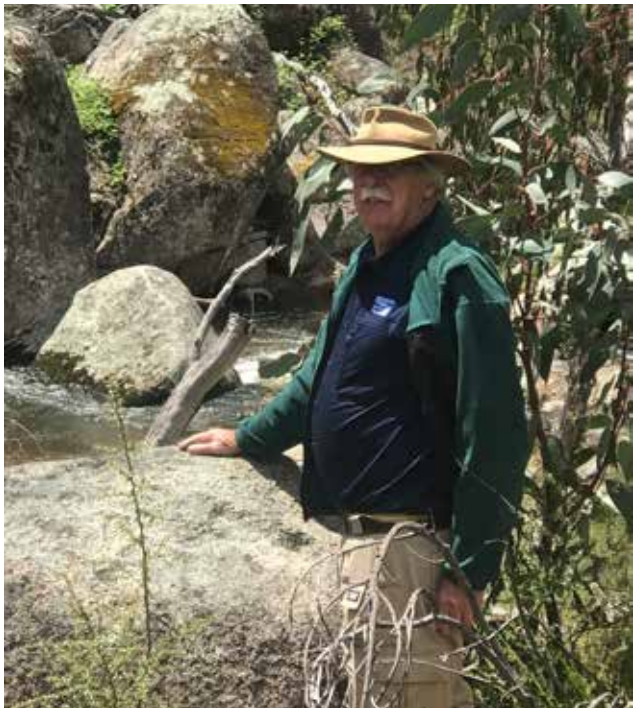
Even though 2021 was a slightly wetter year than 2022, the catchment was still absorbing the rainfall, filling dams and recharging groundwater tables. This year's results have highlighted that once the catchment is saturated, the greater responsiveness of flows to rain events and more frequent high-energy flows, leave certain urban and rural waterways vulnerable to erosion and scouring due to a lack of structural integrity. There were noted increases in streambank erosion in reaches where in-stream and riparian native vegetation were lacking. This included rural rivers such as the lower Bredbo and Numeralla Rivers as well as small tributaries, including those downstream of new and existing urban development such as Deep Creek and Weston Creek in the lower Molonglo catchment.




ACT VENTURERS

Cooma Region Catchment Facts

The Cooma Region catchment includes the upper Murrumbidgee River south of the ACT, plus the Bredbo, Numeralla, Kybeyan and Badja river sub-catchments. This is Ngarigo and Ngunnawal country. The headwaters of the upper Murrumbidgee are also the shared responsibility of the Ngarigo, Walgalu and Wiradjuri peoples. These sub-catchments provide the majority of inflows for the upper Murrumbidgee River upstream of the ACT as 95% of its headwaters are diverted at Tantangara Dam as part of the Snowy Hydro Scheme.

Land use in the Cooma Region includes urban, rural residential, rural (grazing and cropping) and conservation. The lower lying, more fertile areas of the catchment are generally cleared and modified with more intensive land use and limited native riparian vegetation. The headwaters of catchments are generally less modified and are in better condition. Protection of in-stream and riparian (riverbank) habitat needs to be prioritised in these areas.

The Actions for Clean Water (ACWA) Plan sets out a strategy for improving water quality (targeting turbidity) in the upper Murrumbidgee catchment. It identifies the Numeralla and Bredbo River catchments as areas where erosion risk is very high. Addressing erosion goes hand in hand with maintaining and restoring native vegetation and high levels of groundcover while reducing the impact of invasive weeds. These issues are the focus of Landcare groups and regional catchment organisations in the Cooma Region.

The upper Murrumbidgee River has areas of high-quality aquatic habitat where species such as Murray cod, Trout cod, Macquarie perch, Murray river crayfish, Platypus, Rakali (Water rats) and Eastern long-necked turtles are found. Protecting these species and improving their habitat is the focus of the Upper Murrumbidgee Demonstration Reach (UMDR) initiative. The UMDR works with many partners, including Waterwatch, and focusses on the upper Murrumbidgee River between Tantangara and Burrinjuck Dams.

Waterwatch volunteers have been monitoring river health in the Cooma Region since 2010.

Cooma Catchment Health Summary

2022 saw a continuation of the better flows due to the high rainfall seen over the past few years, with many long-term locals commenting that flows were the highest they had seen for decades. This, coupled with snowfalls right into late Spring made for an interesting year!

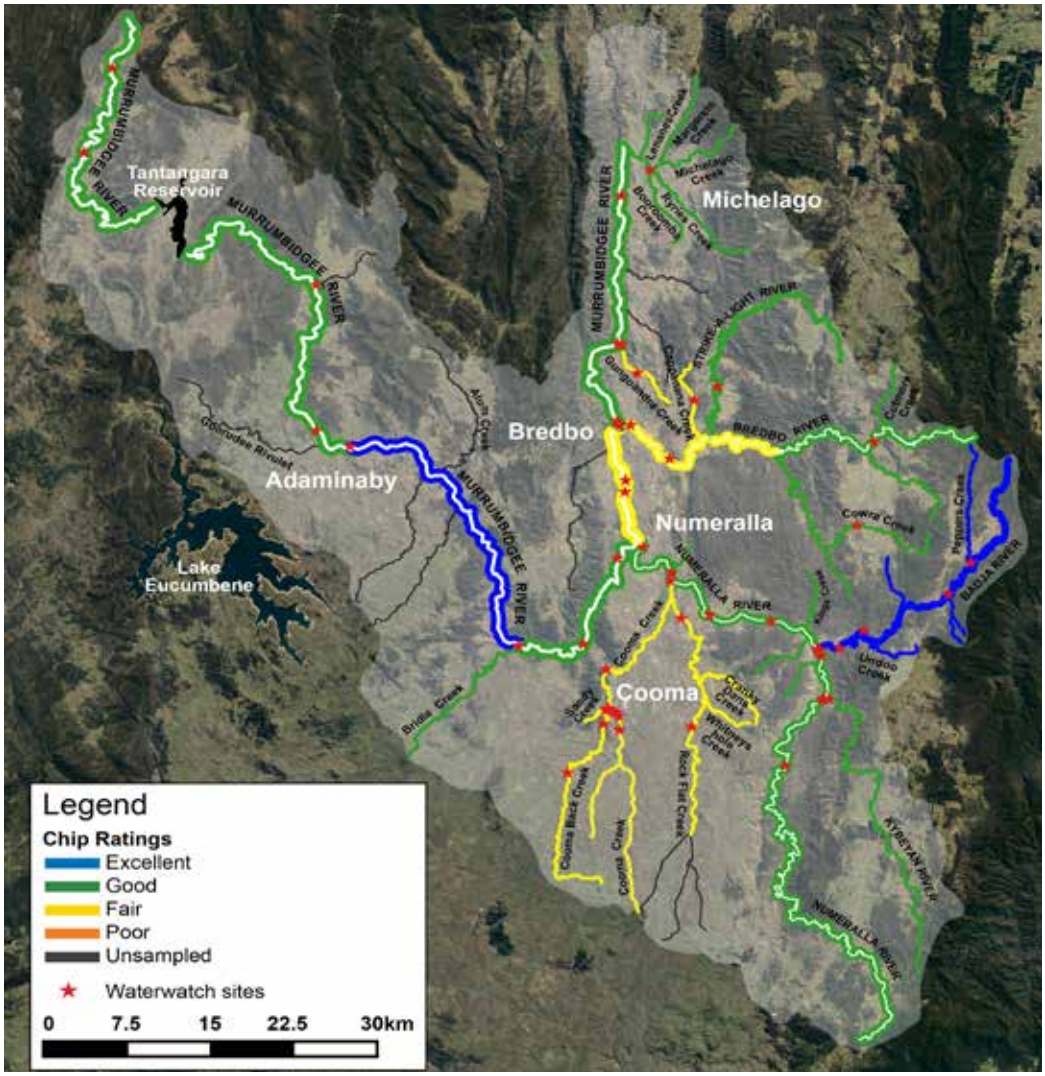
Replenished groundwater supplies meant that flows have in part been sustained from groundwater sources which typically yield clear water. Accordingly, 14 out of 23 reaches in the Cooma Region reported an *excellent* score for water quality this year and another four reaches reported *good* scores.

It is important to be mindful that inadvertent nutrient or pesticide build up in soils can also be mobilised during times of better flows. Increased stormwater inputs may also carry with them pollutants and this too affects water quality scores. This was seen when phosphorous levels were regularly detected at *degraded* or *poor* levels in the Cooma Creek catchment (COB1, COO1 to COO3) and nearby Rock Flat Creek (ROC1).

In some reaches flows have had a scouring effect on the channel, highlighting the dynamic nature of aquatic ecosystems. There were noted increases in streambank erosion in reaches where in-stream and riparian native vegetation was lacking. This includes the lower sections of the Bredbo River (BRD2), the Numeralla River and Cooma Creek. Waterbug scores also declined in many reaches, driven in part by high flows and reduced habitat. This drove an overall decline in condition scores with 12 out of 23 reaches declining to some degree, compared to 2021. This highlights the importance of vegetated riparian zones and good in-stream habitat to provide beneficial filtration, bank stabilisation and in-stream habitat to support aquatic processes and food chains.

Actions to improve river health in the Cooma Region have continued in 2022 carried out by Local Land Services, Rivers of Carbon, the UMDR, Landcare groups, Bush Heritage Australia, the Bredbo Fishing Club and landholders. These included woody weed control, erosion mitigation and installing in-stream habitat, removing European carp, riparian plantings and fencing out stock.

This year we were sad to farewell Phil Irons- keen fly fisher and loving and dedicated partner of Waterwatcher Kerryn who he supported to monitor sites in three reaches. His contribution is gratefully acknowledged.



Badja River BAD1
Headwaters to Undoo Creek

2022 CHIP Result A- (Excellent)		
2021 CHIP Result A (Excellent)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**22**
pH	Good	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Waterbug	**Excellent**	**2**
Riparian condition	**Good**	**2**

Reach Facts

Reach network length: approx. 51km
Dominant land uses: Rural and conservation

The Badja River rises in the Badja Swamps Nature Reserve which includes the nationally-listed Big Badja Swamp. From there the reach flows through open, historically cleared country and then on through steeper, uncleared country with good native vegetation cover. Up until December 2019, this reach was one of the healthiest streams in the Cooma Region, with consistently *excellent* water quality, abundant and diverse waterbugs and good riparian condition.

The 2019/20 bushfires greatly impacted this reach with fire burning out most of the catchment. Three years on, much of the riparian shrub and canopy layer vegetation has yet to recover properly. The higher than average rainfall over the last three years has been very favourable, resulting in replenished groundwater and good groundcover being established in this part of the catchment. Several larger flow events have flushed the heavy ash and sediment from in-stream habitats, which was washed into the river after the bushfires. This has contributed to improved waterbug survey results, which have been *excellent* for the last couple of years.

Good groundcover in the catchment is helping to filter run-off, and is ensuring turbidity levels were crystal clear for the entire year. The *degraded* dissolved oxygen score may be associated with increased organic matter washed into the stream due to high rainfall and flow events.

At the end of 2022, long-standing Waterwatcher, Jim has completed 588 surveys! Jim samples at four sites across reaches BAD1 and BAD2. A tremendous effort.

The canopy and shrub layers at BAD600 are still recovering three years on from the 2019/20 bushfires

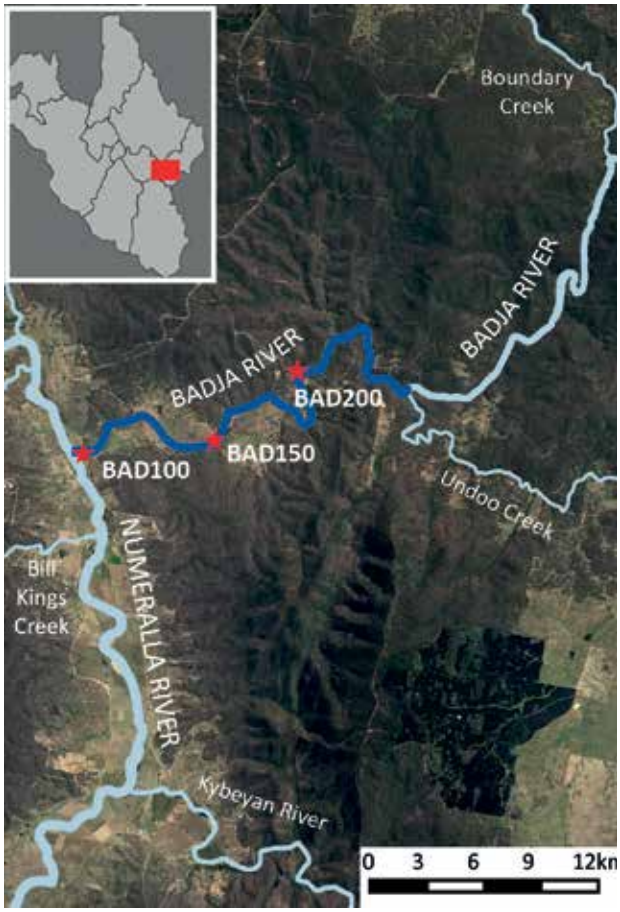
Badja River BAD2

Undoo Creek to Numeralla River

2022 CHIP Result A- (Excellent)

2021 CHIP Result B+ (Good)

Parameter	Rating	No. Survey
Water quality	**Excellent**	**32**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Fair	
Waterbug	**Excellent**	**2**
Riparian condition	**Fair**	**3**



Reach Facts

Reach network length: approx. 8.6km
Dominant land uses: Rural and rural residential

The lower section of the Badja River runs through open, cleared country used predominantly for rural residential, grazing and some dryland cropping. In contrast to the upstream section (BAD1), the cumulative impact of increased rural and residential activities and historic land use changes are evident here. This section of the Badja is known to become turbid during high run-off events, European carp are present and there is an increase in woody weeds such as willows and blackberries. Gold fossicking activities are having an increasing impact on the riparian zone near BAD200, with a large area of the riparian zone being disturbed by illegal fossicking activities at the site during 2022.

The 2019/20 bushfires heavily impacted the catchment in the upper section of this reach, resulting in heavy ash and sediment flowing into the river. The higher-than-average rainfall and good flows over the last three years are having a positive impact on riparian and in-stream habitat as well as water quality, seeing the reach improve from a consistently good score since 2019 to *excellent* in 2022.

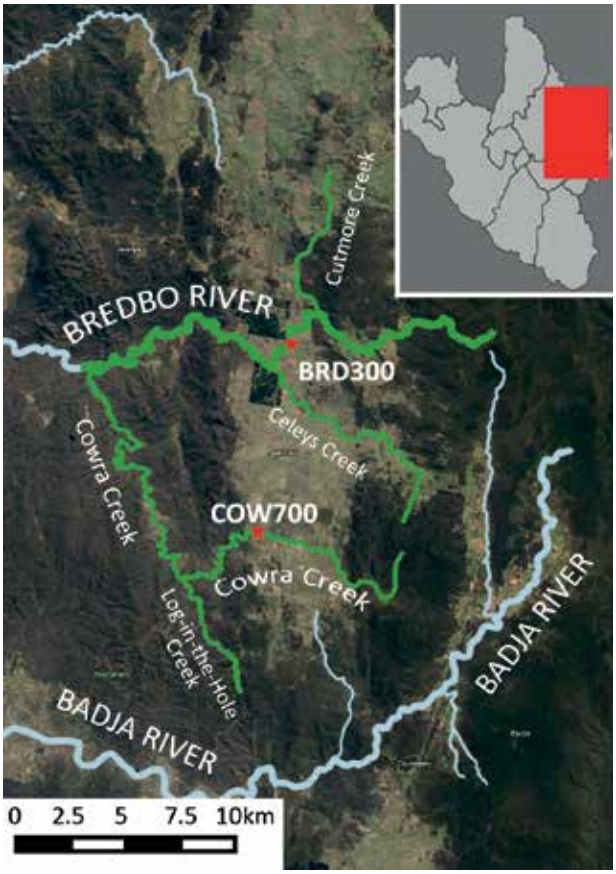
The waterbug survey results have driven the improvement and are a good overall indicator of river health due to the fact that both in-stream habitat and water quality are factors that support abundance and diversity of waterbugs. The survey results included good diversity in the most pollution-sensitive waterbugs groups including two types of stoneflies, four types of mayflies and three types of caddisflies.

Fossicking at BAD200 resulted in disturbance of the riparian zone as well as a trailer being dumped on site

Bredbo River BRD1

Headwaters to Cowra Creek confluence

2022 CHIP Result B+ (Good)		
2021 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**19**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Fair	
Waterbug	**Excellent**	**2**
Riparian condition	**Fair**	**2**



Reach Facts

Reach network length: approx. 33km
Dominant land uses: Rural

This reach runs through a mix of unmodified and cleared grazing country. Generally intact groundcover is retained throughout the catchment which in turn protects water quality. Some gully erosion is, however, found in the middle of the Cowra Creek catchment, which is related to historical gold mining and land use activities such as clearing and grazing. Our Waterwatch sites are upstream of this area.

A large part of the upper Bredbo and Cowra Creek catchments were impacted by bushfires in early 2020. These parts of the reach are still showing signs of recovery three years later with the help of the wet conditions throughout 2021 and 2022. Abundant groundcover has established across the catchment and consistent high flows has seen new channels forming in-stream.

Waterwatcher and long-term landholder at site BRD300, Phil Thurbon, notes that water levels like this have not been seen for decades. He noted that flood debris could be seen as high as 1.5m above the river level at the site in early October, 2022.

Encouragingly, water bug surveys reported an *excellent* score for the second year in a row. The diversity and abundance of waterbugs were notable with three types of stonefly, five types of mayfly, six types of caddisfly as well as Megaloptera 'toe-biters', a large, predatory waterbug. In the spring survey alone, there were over 260 mayfly nymphs counted. All these Orders are rated as very sensitive to pollution and are an excellent reflection on the health of the upper Bredbo River.

Waterwatch volunteer, Phil Thurbon, sampling water quality at BRD300 in Spring 2022

Bredbo River BRD2

Cowra Creek to Murrumbidgee River

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**16**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Excellent	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**

Reach Facts

Reach network length: approx. 25km
Dominant land uses: Rural including dryland cropping and grazing

The lower end of this reach has wide alluvial floodplains which are used for dryland cropping and grazing. In some areas, stock are allowed to graze the river corridor. The Bredbo Landcare Group is working at the confluence to control riparian weeds and improve native trees, shrubs and grasses via the Two Rivers Wattle Park Drive project.

This reach is in a high priority ACWA catchment with five priority erosion sites identified. Historic and current land use activities have resulted in large amounts of sand and sediment washing down from the catchment which is now smothering aquatic habitat. During high flow events, turbidity can become very high. Exotic species including African lovegrass, blackberry, willow and poplars dominate the riparian vegetation. In the downstream section of this reach, native reed beds are stabilising sand bars which is helping re-establish a defined river channel and increasing in-stream habitat.

High flows continued throughout 2022 which saw ongoing streambank erosion along this reach, especially in areas where deep rooted native vegetation is limited. Successive flood events saw new deposits of sand and ash at the confluence, indicating the ongoing mobility of both fine and gross sediment in the system. This year's waterbug survey results reflected this with the majority of bugs found belonging to the Orders of Hemiptera (true bugs) and Diptera (fly larvae) which are tolerant of both poor habitat and water quality.

Streambank erosion is evident on the lower Bredbo River (BRD100) after several years of higher flows

Cooma Creek COO1

Headwaters to Banksia Lane

2022 CHIP Result C (Fair)		
2021 CHIP Result C- (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**22**
pH	Good	
Turbidity	Fair	
Phosphorus	Poor	
Nitrate	Degraded	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Fair	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 22km
Dominant land uses: Rural and urban

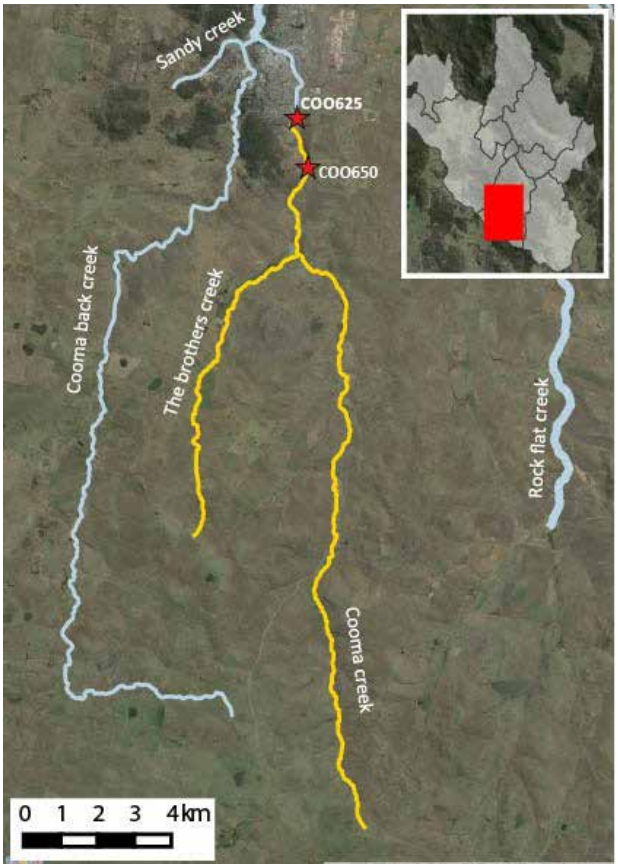
The headwaters of Cooma Creek flow through open, basalt country and this geology influences electrical conductivity scores in this catchment. The fertile floodplains of the reach are used for dryland cropping and grazing agriculture. Native vegetation has been historically modified and in-stream vegetation such as reeds and sedges, which are beneficial for stability and nutrient retention, are largely absent.

Much of the upper section of Cooma Creek is unfenced and stock access can result in reduced ground cover and increased erosion. Cropping and cultivation activities means floodplain groundcover is laid bare at times and vulnerable to wash off during high intensity storm events.

Flood events in 2022 saw high amounts of sediment deposited at COO625 and a reduction in in-stream reeds. A flash flooding event in late October 2022 was compounded by an already saturated landscape, resulting in overtopped levee banks within Cooma township.

A increase in turbidity could indicate erosion upstream and increased nutrients highlight the fact that during wetter periods nutrients can be mobilised. Good flows have seen an improvement in dissolved oxygen compared to 2021.

Waterbug results drove a slight improvement in the overall reach score compared to last year. There was good bug diversity (>10 types) found in both Autumn and Spring, including mayflies, which require good oxygen levels. Otherwise the surveys were dominated by pollution-tolerant bug types such as true bugs (Hemiptera) and segmented worms.



Cooma Creek at COO650 had flood debris high up in the trees indicating the height of the October flood

Cooma Creek COO2

Banksia Lane to Cooma Back Creek confluence

2022 CHIP Result C- (Fair)		
2021 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**22**
pH	Good	
Turbidity	Fair	
Phosphorus	Degraded	
Nitrate	Degraded	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Good	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 3km
Dominant land uses: Urban

This reach flows through the township of Cooma where flood mitigation levees and a popular walking path have been constructed along its length. Stormwater from the town is discharged directly into the creek and litter is an ongoing problem.

In-stream and creekside habitats are greatly modified with little native vegetation remaining. The small amount of habitat which is present, such as reeds and long grass, is highly important to support the creek's biodiversity including ducks, Swamp hens, five frog species, Mountain galaxias (a small native fish), Rakali (native water rat) and Platypus all of which have been spotted right in the middle of town.

Medium to high flows have continued throughout 2022 including a flash flooding event in late October which outflanked the levee banks, flooding adjoining buildings. The flows have mobilised nutrients and dissolved salts and minerals, as well as increased turbidity. Such results were also seen upstream but it is exacerbated in this reach by pollution present in the urban stormwater inflows. Waterbug surveys reflect this trend and were dominated by waterbug types that are tolerant of increased nutrients and organic matter. These include freshwater snails, segmented worms and fly larvae.

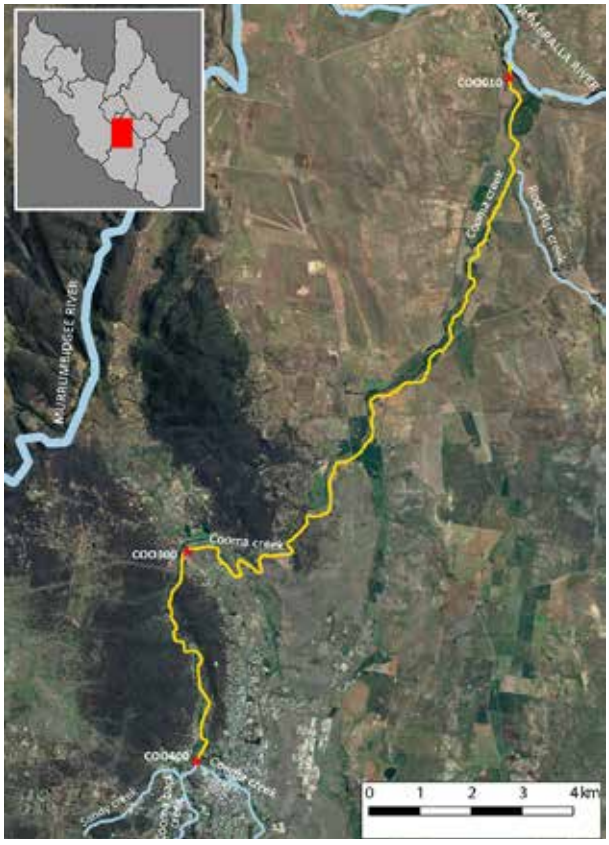
Improving the habitat and health of Cooma's creeks is a focus of the Cooma Landcare Group and is supported by Cooma Waterwatch. This includes regular litter clean-ups along this reach, raising awareness about in-stream habitats such as reed beds and monitoring frog species via the FrogWatch program.

Unexpected flash flooding caught Cooma unawares on the 24th October 2022 (photo: M.Mannile)

Cooma Creek COO3

Cooma Back Creek confluence to Numeralla River

2022 CHIP Result C- (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**29**
pH	Good	
Turbidity	Excellent	
Phosphorus	Degraded	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Fair	
Waterbug	**Poor**	**2**
Riparian condition	**Poor**	**4**



Reach Facts

Reach network length: approx. 18km
Dominant land uses: Conservation, rural residential and rural

This reach includes the Cooma Creek downstream of Cooma to its confluence with the Numeralla River. It is flanked by the North Ridge Nature Reserve at its upper end (which has better riparian vegetation), rural residential holdings in the Mittagang Road area (in the middle of the reach) and wide river flats which are used for irrigated cropping at the bottom end of the reach.

The lower section of this reach has been highly modified and riparian vegetation is very reduced, with a general lack of deep rooted native vegetation present. This part of the reach is dominated by a sand filled channel with little in-stream habitat and this has a negative effect on the waterbug score.

A farmer adjoining site COO010 notes that the flood event in late October inundated most of the floodplain, depositing willow debris in some areas and scouring top soil in others. This scouring effect also occurs in-stream and so can also influence waterbug numbers. Even though the Spring waterbug survey for this reach was conducted four weeks after the flood event, a lack of diversity was apparent.

Cooma's Sewage Treatment Plant is located downstream of COO300 and nitrate levels as high as 20mg/L have been recorded in dryer years. This year the highest nitrate reading recorded was 5 mg/L which is unsurprising given the increased flows.

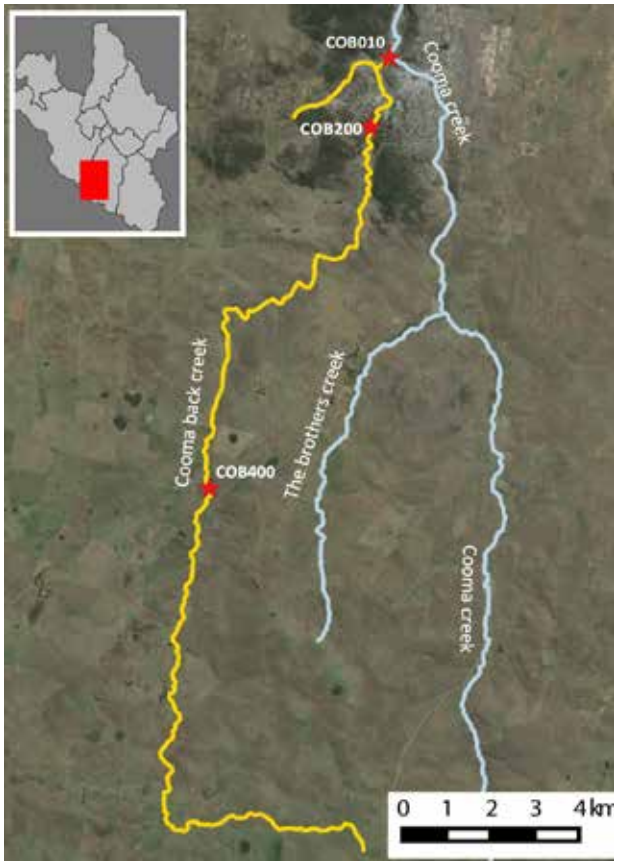
Platypus are monitored at the top end of this reach, with a very active Rakali and one Platypus recorded during the surveys.

Cooma Creek saw increased algal growth in Spring due to high nutrients and warmer temperatures

Cooma Back Creek COB1

Headwaters to Cooma Creek

2022 CHIP Result C (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**26**
pH	Good	
Turbidity	Good	
Phosphorus	Degraded	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**



Reach Facts

Reach network length: approx. 30km
Dominant land uses: Conservation, urban, rural residential and rural

This reach includes the entire Cooma Back Creek and tributaries. The upper section of the reach flows through open, cleared country used for grazing and dryland cropping. The lower section of the reach includes Coolamatong (Lambie Gorge), a cultural site significant to the Ngarigo people. FrogWatch surveys conducted on the creek at the downstream end of Coolamatong show the highest frog diversity in the Cooma township area, with five species being recorded.

Riparian plantings are being carried out on the creek below the Coolamatong by Cooma Landcare to help enhance habitat for frogs and improve bank stability. Increasing willow and Box elder growth is an ongoing issue in the bottom half of the reach and an ongoing focus on reducing exotic plants and replanting native vegetation in this reach will, in time, improve the riparian health.

2022 saw better flows in this reach, which usually corresponds with better water quality, particularly for parameters such as dissolved oxygen. This reach, however, has bucked the trend, with all water quality parameters declining compared to 2021. The low dissolved oxygen scores could be an indication that nutrient laden organic matter is present.

The waterbug score also showed a slight decline, with the bugs present being dominated mostly by pollution-tolerant types. These included segmented worms and snails that benefit from rich organic matter, higher nutrients and lower dissolved oxygen conditions. Over two-thirds of the waterbugs found in the Spring sample were only worms and snails.

In-stream vegetation at Cooma Back Creek at Kiah Ave (COB200) has benefitted from good flows

Gungoandra Creek GUD1

Headwaters to Murrumbidgee River

2022 CHIP Result C+ (Fair)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**24**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Poor	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 9km
Dominant land uses: Rural and conservation

This reach includes the entire Gungoandra Creek. The upper section of the creek has been cleared and is used for grazing. The lower section (which includes the two Waterwatch sites) is managed for conservation by Bush Heritage Australia (BHA) as part of their Scottsdale Reserve.

Removal of stock has seen native reeds establishing along the length of the creek at Scottsdale which provides positive benefits such as filtering the water, settling sediment, in-stream habitat and stabilising the stream channel. Mountain galaxias (a small, native fish), Rakali (native water rat), Platypus and Latham's snipe (a threatened, migratory waterbird) have all been sighted along the creek. Restoration works have been supported by Local Land Services and the Upper Murrumbidgee Demonstration Reach via the Rivers of Carbon program.

The entire catchment was impacted by bushfires in February 2020. This year's *excellent* water quality results for turbidity, nitrates and phosphorous, are supported by the filtering functions of in-stream reeds which have fully re-established since the fires. Electrical conductivity is naturally high in this reach due to geological sources.

While the good flows throughout the year had a positive effect on water quality, the constant flushing may have played a role in the reduced diversity and abundance noted in the waterbug surveys. While only seven and eight Orders were found over both surveys, there was, pleasingly, a dominance of pollution-sensitive waterbugs. This included three different types of mayflies and five different types of caddisfly larvae.

Waterwatcher Alistair monitors the Gungoandra Creek where reed beds help filter and stabilise the waterway

Kybeyan River KYB1

Headwaters to Numeralla River

2022 CHIP Result B- (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**9**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Good	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**1**

Reach Facts

Reach network length: approx. 49km
Dominant land uses: Rural and conservation

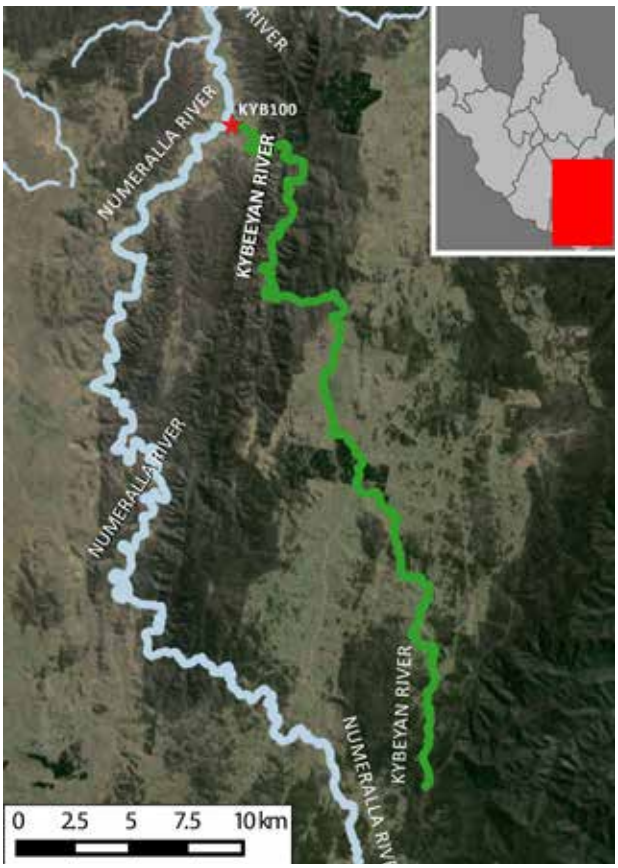
This reach includes the entire Kybeyan River catchment. The river has cleared grazing country around its headwaters, from where it flows through steep, unmodified country and then on to join the Numeralla River. There is an ACWA site on a tributary gully at the bottom end of this reach.

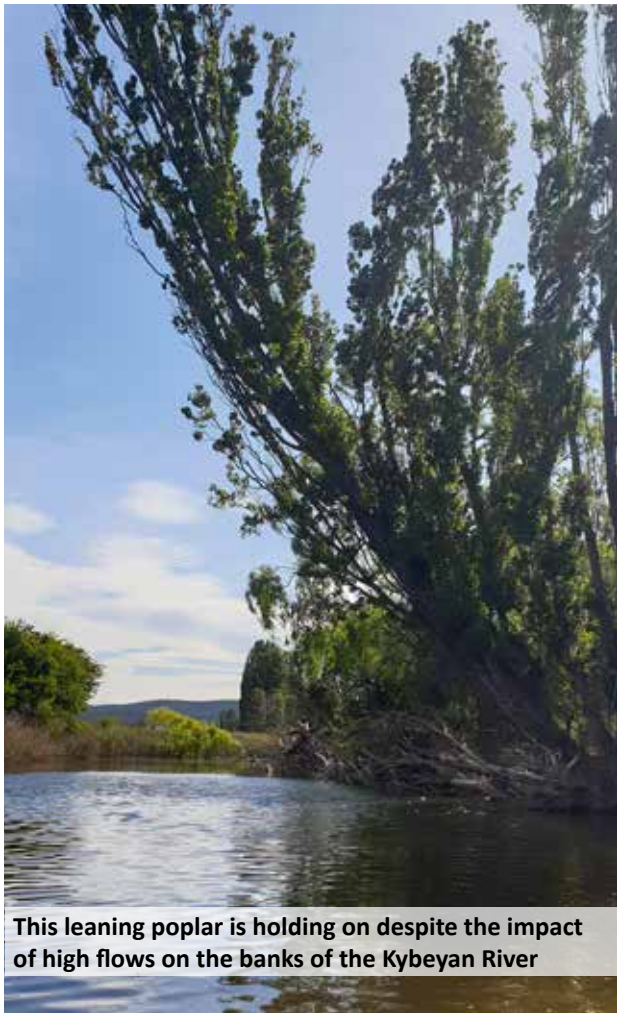
In the last three years the river has experienced steady medium-high flows which had very low turbidity overall. This has been a good indication of intact groundcover and limited streambank erosion in the catchment. This, combined with persistent flows has resulted in improvements in dissolved oxygen and another *excellent* score overall for water quality in 2022.

The waterbug habitat at the site lacks the variety seen at other sites, such as riffles and large woody debris. The stands of Typha (a native reed) were also noted as being much reduced in November after good flows throughout Winter and Spring. Accordingly there was a reduction in diversity and abundance of waterbugs in comparison to the previous year which drove down the overall CHIP score.

The adjoining landholder notes that 20 years ago Trout were plentiful and Platypus sightings common. In contrast, European carp are now more often sighted, Eastern gambusia (a small pest fish) have been seen at the site in large numbers and Platypus are sighted only very occasionally.

This reach has only one site and another volunteer to monitor an additional site further upstream would greatly enhance our knowledge of this catchment.





This leaning poplar is holding on despite the impact of high flows on the banks of the Kybeyan River

Michelago Creek MIC1

Headwaters to Murrumbidgee River

2022 CHIP Result B- (Good)		
2021 CHIP Result C+(Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**11**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Poor	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**1**

Reach Facts

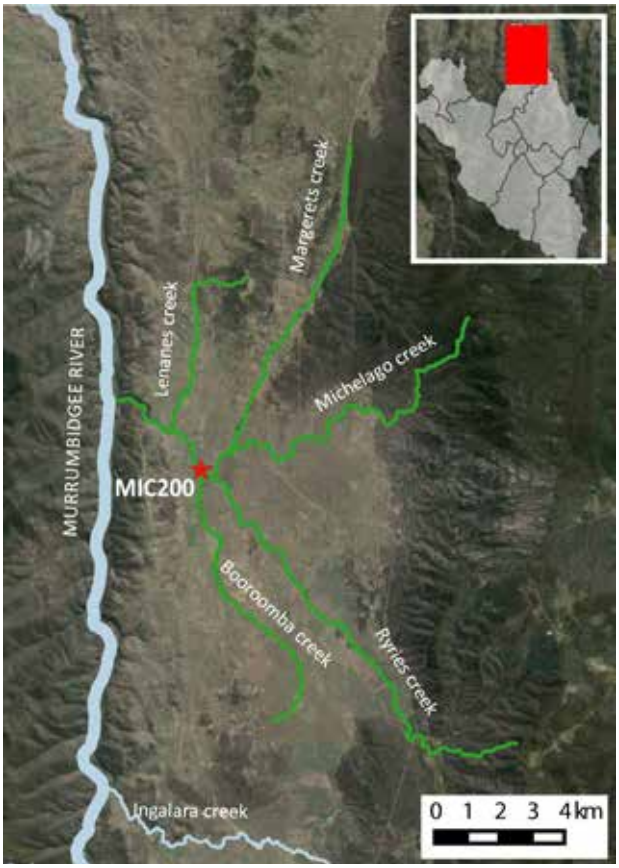
Reach network length: approx. 55km
Dominant land uses: Rural, rural residential and conservation

This reach includes the entire Michelago Creek catchment including the Margeret and Ryries Creek. The upper sections of these creeks retain native, unmodified vegetation where they arise in the Tinderry Range. The lower sections flow through open, historically cleared country used for grazing and is also the location of the village of Michelago. Current and historical land use has resulted in *poor* riparian condition with very limited native vegetation remaining, having been replaced by exotic species such as poplars and willows.

Michelago Landcare have previously conducted work along the creek, controlling willows, replanting native riparian vegetation and installing rock gabions to stabilise streambanks.

Within the village of Michelago, large stands of reeds have established in-stream which is having a stabilising effect as well as providing habitat. The creek lacks a diversity of waterbug habitat such as snags, riffles and overhanging ti-tree. That said, a high diversity and abundance of waterbugs was sampled at both surveys this year with eleven different Orders detected. A couple of Mountain galaxias, a small, native fish, were also caught in the Spring sample.

The top of the catchment was burnt in the 2019/20 bushfires and a thick layer of ashen silt can still be observed on the bottom of the creek bed and on the riverbanks. Electrical conductivity is naturally high in this reach due to the geology of the catchment. Phosphorous concentrations are slightly elevated compared to the previous year.



Waterwatch Coordinator, Jed, heading into the reeds on Michelago Creek to conduct a bug survey in December

Murrumbidgee River CMM1

Headwaters to Tantangara Dam

2022 CHIP Result B+ (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**17**
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Good	
Waterbug	**Excellent**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 53km
Dominant land uses: Conservation

This reach is the Murrumbidgee River from its headwaters to Tantangara Dam and is entirely within Kosciuszko National Park. The vegetation in the catchment includes heaths, grasslands, bogs and subalpine woodlands typical of the Australian Alps bioregion. The area is used for camping, fishing and touring. It is closed between the June and October long weekends and is not monitored during this time.

When monitoring began in this reach, water quality and waterbug surveys showed consistently high scores. The river had crystal clear water, low nutrient concentrations, neutral pH and very low electrical conductivity. Waterbug surveys had very high species diversity including many of the most sensitive bug types.

Over the last years, however, we have been observing that the banks are increasingly pugged (destabilised by hard hooves of feral horses), the riverbanks heavily grazed and algal growth and sedimentation are increasing. While overall water quality and waterbugs scored *excellent* this year (as we would expect after several years of good flows), in drier years, some measurements are beginning to show a decline, such as increased nutrient readings. Overall, waterbug surveys are detecting less pollution-sensitive species with some highly sensitive bugs now missing altogether compared to earlier years.

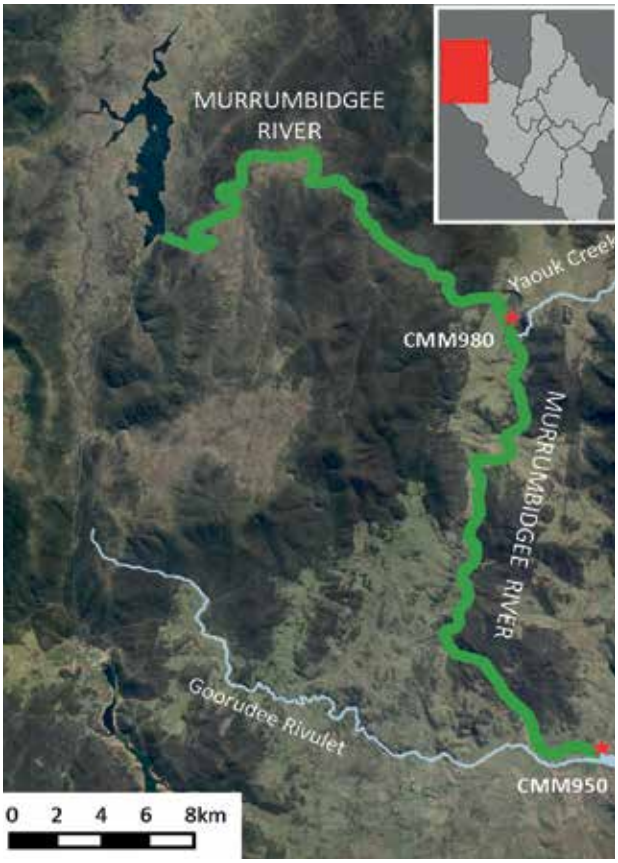
Riparian vegetation only scores *poor* for this reach as the lack of canopy and shrub layers characteristic for natural tussock grasslands is not accounted for by the riparian survey method used by the CHIP.

Murrumbidgee River at Long Plain Rd Crossing (CMM995)

Murrumbidgee River CMM2

Tantangara Dam to Goorudee Rivulet confluence

2022 CHIP Result B+ (Good)		
2021 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**19**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**2**



Reach Facts

Reach network length: approx. 55km
Dominant land uses: Rural

This reach includes the Murrumbidgee River and its tributaries immediately downstream of Tantangara Dam. The catchment comprises of open valley floors with swampy meadows/tussock grasslands (now used for grazing and opportunistic dryland cropping in places) and steep unmodified gorge country. Riparian vegetation scores are *poor* as the lack of the canopy layer in natural tussock grasslands at the survey sites, is not accounted for by the riparian survey method used for the CHIP.

Tantangara Dam diverts 95% of river flows to Eucumbene Dam as part of the Snowy Mountains Hydro scheme and this affects flows in the reach. The impact of flow regulation is very evident with in-stream habitat and aquatic species present exhibiting the characteristics of slower flowing ecosystems rather than a fast-flowing upland stream. Water-lillies, for example, are growing at the edges and there is an increase in fine sediment building up in the substrate when flows are low. Ash washed in from the 2019/20 bushfires has exacerbated this issue.

The *excellent* water quality scores reflect the near-pristine water released out of Tantangara Dam, as well as the healthy inflows and good groundcover experienced in the surrounding catchments from the consistent wet weather.

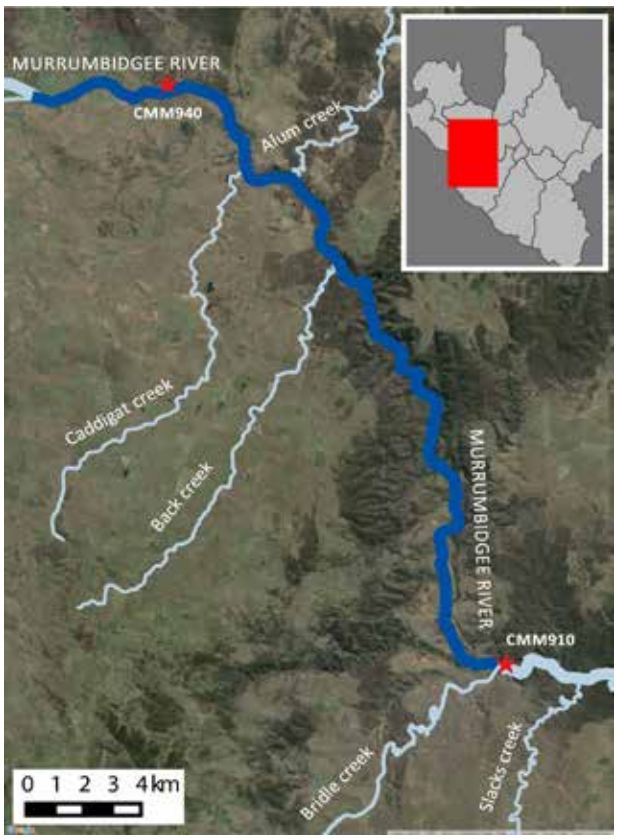
A nationally significant population Macquarie perch occur in this section of the upper Murrumbidgee River. European carp and Redfin perch are not recorded in this reach and any sightings should be reported to NSW Fisheries.

Good flows this year have benefitted the in-stream vegetation at CMM980

Murrumbidgee River CMM3

Goorudee Rivulet to Bridle Creek confluence

2022 CHIP Result A- (Excellent)		
2021 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**15**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	**Excellent**	**2**
Riparian condition	**Fair**	**2**



Reach Facts

Reach network length: approx. 43km
Dominant land uses: Rural and conservation

This reach includes the Murrumbidgee River from Goorudee Rivulet down to the area known as 'Dry Plains'. This reach firstly flows through more open, undulating country (used predominantly for grazing and dryland cropping purposes) and then through steeper gorge country dominated by woodland vegetation cover which remains largely unmodified.

There is a concerning build up of fine and sandy sediments in backwaters, riffle and cobble habitats along this reach. Our water quality monitoring shows that during flood events turbidity can become elevated and may indicate active gully and streambank erosion. This results in in-stream sedimentation which can affect the recruitment of the nationally significant Macquarie perch population present in the reach. This species relies on clean, sediment free riffles to breed. NSW Local Land Services and project partners are making headway to protect Macquarie perch habitat by controlling willows, mitigating erosion and working with landholders to revegetate riparian zones and manage stock access.

The reach score improved this year, largely driven by the waterbug results. This year's score reflects the high proportion and diversity of very pollution-sensitive waterbugs such as stoneflies, mayflies and caddisflies found in both the Autumn and Spring surveys.

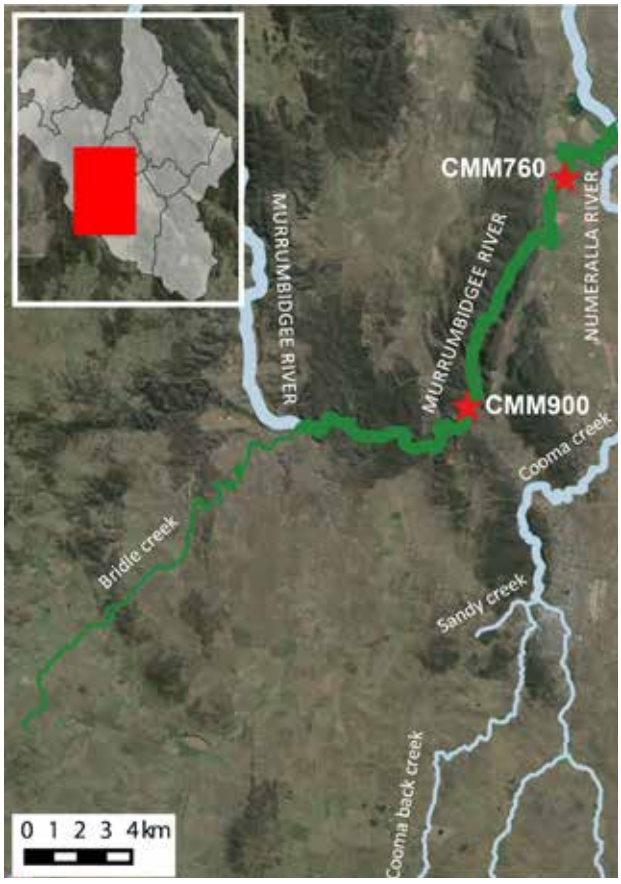
The most upstream sightings of European carp in the upper Murrumbidgee River occurs in this reach. Redfin perch are absent and sightings should be reported to NSW Fisheries given they pose a threat to the Macquarie perch population.

Vale Phil Irons, who was a Waterwatch champion and supported his partner Kerryn to monitor multiple sites

Murrumbidgee River CMM4

Bridle Creek to Numeralla River confluence

2022 CHIP Result B- (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**23**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**1**



Reach Facts

Reach network length: approx. 31km
Dominant land uses: Rural and conservation

This reach includes the Murrumbidgee River from Bridle Creek to the Numeralla River confluence. The upper section of this reach adjoins the Binjura Nature Reserve, including the Cooma Gorge which contains high quality riparian and aquatic habitat. This area is the known breeding habitat of a nationally significant Macquarie perch population, a threatened fish species. Downstream of the gorge the river adjoins wide alluvial floodplains which are used for grazing and cropping agriculture.

The 'Reaching for Recovery of the Macquarie perch' project is working to carry out willow control, revegetate riparian zones, manage stock access and replace in-stream habitat. This will help habitat condition and connectivity, stabilise streambanks and improve water quality and waterbug scores.

In-stream sediment has notably increased since the 2019/20 bushfires which saw ash and sediment being washed from the fireground upstream in the catchment. This sediment continues to be remobilised and redeposited on the riverbed and along banks during each flood event, affecting water quality including turbidity. During a flooding event in October, Waterwatcher Mike recorded turbidity at 50NTU and phosphorous concentrations of 0.05mg/L.

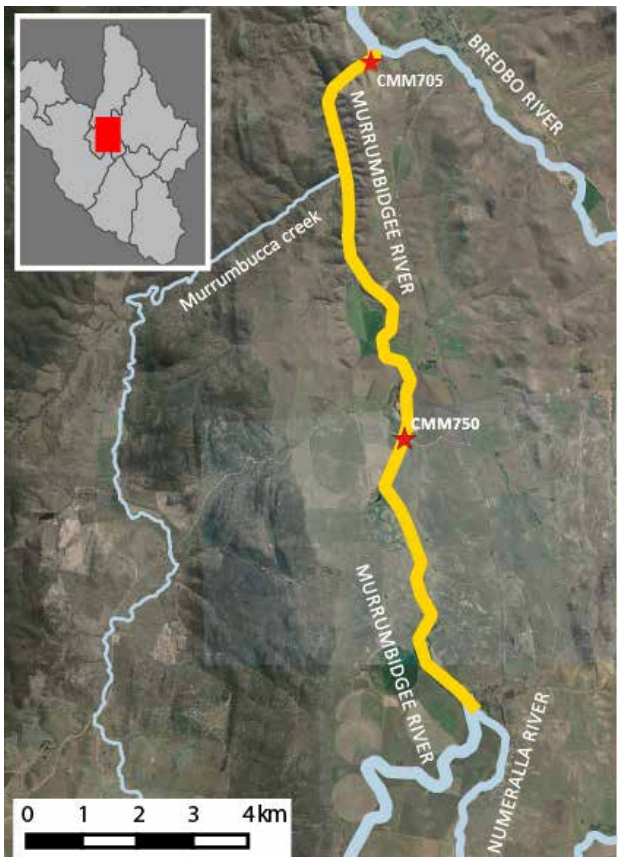
There is a Platypus Month survey site at the top of this reach, where Platypus and Rakali (native water rat) have both been observed. Redfin perch, a feral fish species which are known to carry a virus deadly to Macquarie perch and trout, are absent and any sightings should be reported to NSW Fisheries.

Fish habitat works will help improve in-stream condition

Murrumbidgee River CMM5

Numeralla River to Bredbo River confluence

2022 CHIP Result C (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**12**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Waterbug	**Degraded**	**2**
Riparian condition	**Poor**	**2**



Reach Facts

Reach network length: approx. 12km
Dominant land uses: Rural

This reach includes the Murrumbidgee River from the Numeralla River to the Bredbo River confluence. Wide alluvial floodplains flank the river in this reach and are used for dryland and irrigated cropping as well as grazing. Very limited native riparian vegetation remains due to historic clearing and this is reflected in the *poor* riparian condition score.

This reach is in a priority ACWA catchment and there are two ACWA erosion sites present. The Numeralla River is also a source of sand due to historic erosion and bushfires, with sediment continuing to move downstream from this reach. Ashen silt from the 2019/20 fires continues to be observed covering the river substrate. These silty 'sand slugs' clog up the river channel, smother in-stream habitat and provide an ideal area for woody weeds such as willows and Box elder to take hold and spread, especially as good native vegetation cover is absent.

The consistently high water levels have reduced in-stream habitat by scouring out reeds stands, drowning ti-tree and reactivating streambank erosion in this reach. Flood conditions (which can flush waterbugs downstream) coupled with decline in a variety of quality habitat, may have contributed to the decline in the waterbug score from *poor* to *degraded*. The waterbug samples had low diversity of different Orders and high abundance of pollution-tolerant types such as those from the Family Hemiptera (true bugs) which breathe air and can fly away if conditions decline.

Plantings by Bredbo Landcare will help to stabilise banks at the bottom end of this reach

Murrumbidgee River CMM6

Bredbo River to Michelago Creek confluence

2022 CHIP Result B+ (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**20**
pH	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Fair	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**2**

Reach Facts

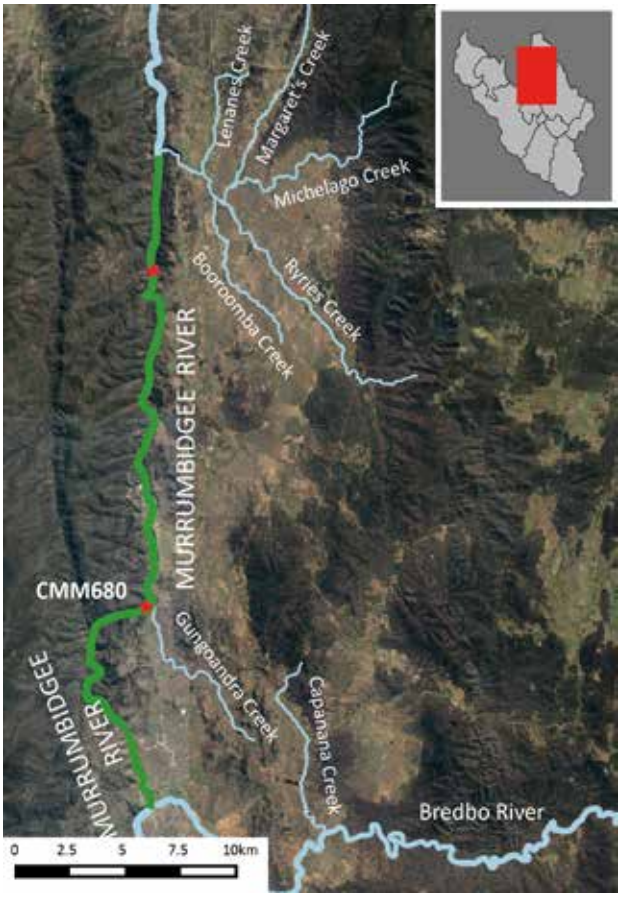
Reach network length: approx. 35km
Dominant land uses: Rural and conservation

This reach includes the Murrumbidgee River from the Bredbo River to the Michelago Creek confluence. It flows through the Bredbo and Colinton gorges which form the upper and lower sections of the reach. These gorge areas contain good quality riparian and aquatic habitat. The middle section flows through the Bumbalong Valley which has more open, cleared country.

This reach demonstrates the importance of high-quality riverine habitats to overall river health. For example, intact riparian and in-stream habitats in the gorge sections capture sediments and absorb nutrients before they enter the waterway, resulting in more stable oxygen levels and clearer water. Macquarie perch, Murray cod, Trout cod and Murray River crayfish, all of which are protected species, are found here.

Bush Heritage Australia (BHA)'s Scottsdale Reserve flanks the lower Bredbo Gorge. BHA carries out Platypus Month surveys and are working to improve the river corridor through riparian restoration, erosion control and installing fish habitat. This is part of the Upper Murrumbidgee Demonstration Reach partnership, which is working with landholders to improve habitat connectivity in this reach.

This reach was heavily impacted by bushfires in early 2020. Subsequent rains resulted in ash and sediment being washed into the river corridor, smothering in-stream habitat. While waterbugs showed signs of improvement this year, spikes of turbidity and nutrients after heavy rainfall are still being detected. Waterwatcher Alison noted local erosion during January sampling and measured turbidity of 210NTU in February when the river was in flood.

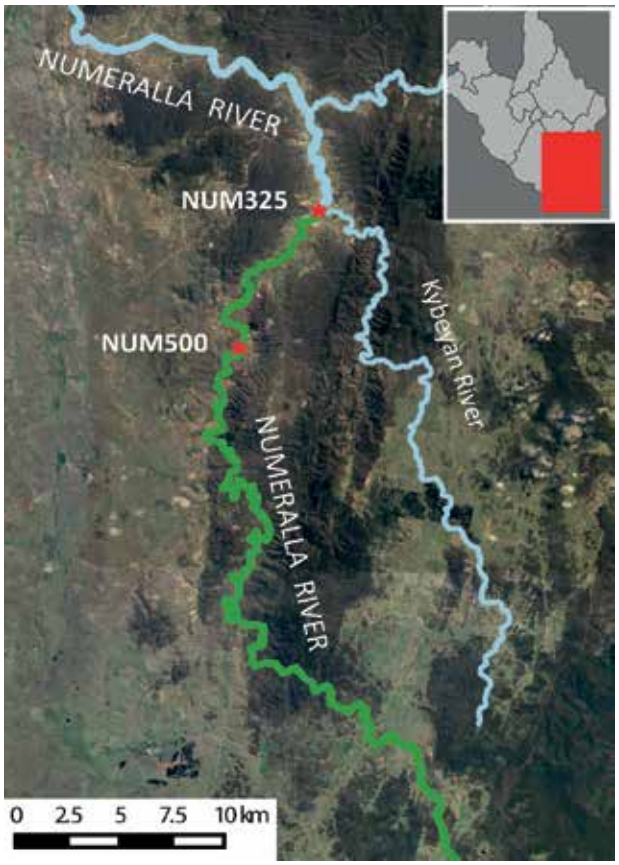


High flows are reactivating bank erosion at Scottsdale Reserve (CMM680)

Numeralla River NUM1

Headwaters to Kybeyan River confluence

2022 CHIP Result B (Good)		
2021 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**15**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Excellent	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**2**



Reach Facts

Reach network length: approx. 38km
Dominant land uses: Rural and conservation

This reach includes the Numeralla River upstream of the Kybeyan River confluence. Land use includes dryland cropping and grazing, especially in the mid to lower sections. In these areas native vegetation has been cleared and historic erosion has contributed large amounts of sand and fine sediment to the river. Sections of the upper reaches retain native vegetation including in the Dangelong Nature Reserve.

Cultivation and grazing affects water quality through elevated electrical conductivity levels. Loss of native vegetation on banks reduces riparian condition scores as well as streambank stability. This reach is a high priority ACWA catchment where erosion risk was assessed as very high.

The Numeralla Landcare Group, Numeralla Fishing Club, landholders and catchment organisations have worked since the 1990s to stabilise streambank erosion, fence the river from stock, replant native vegetation and reintroduce woody habitat in the lower end of this reach. This has stabilised the river channel and improved riparian and in-stream habitat there.

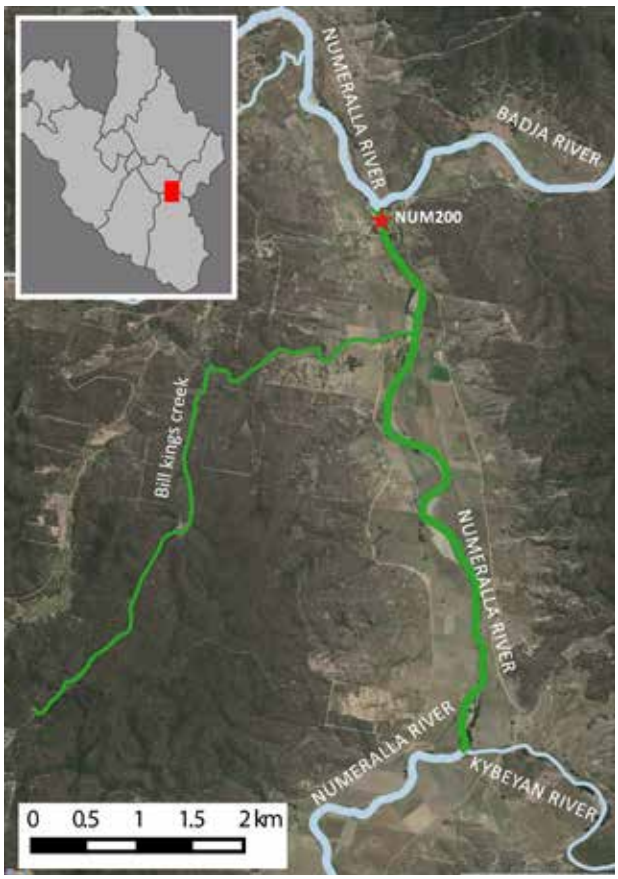
The ongoing works have been very beneficial during the medium to high flows and repeated flooding seen during 2021 and 2022 which put increased pressure on streambanks. Thanks to the many works along the river, treated erosion control sites have remained stable which in turn means turbidity is low. Mike, our Waterwatcher at NUM500, noted that a thick layer of ashen silt (washed down from the 2019/20 bushfires) could be seen on the floodplain after a flood event.

High water levels and flooding overtopped the Mt Forest Road causeway (photo: M.Mannile)

Numeralla River NUM2

Kybeyan River to Badja River confluence

2022 CHIP Result B+ (Good)		
2021 CHIP Result A- (Excellent)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**12**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Fair	
Waterbug	**Excellent**	**2**
Riparian condition	**Fair**	**1**



Reach Facts

Reach network length: approx. 40km
Dominant land uses: Rural and conservation

This reach includes the Numeralla River from the Kybeyan River to the Badja River confluence. It is flanked by wide alluvial floodplains used for dryland cropping and grazing. The Numeralla village is at the bottom end of the reach. Past land use, which has resulted in loss of native vegetation and erosion, has contributed large amounts of sand to the river channel that continues to move downstream. This reach is a high priority ACWA catchment where erosion risk was assessed as very high.

High flows throughout the last years have been sustained from replenished groundwater sources which yield clear, high-quality water. This, in turn, improves water quality and supports a variety of waterbug life, including more pollution-sensitive species. This was seen in both Autumn and Spring surveys where pollution-sensitive mayfly nymphs made up more than half of all bug numbers in both surveys.

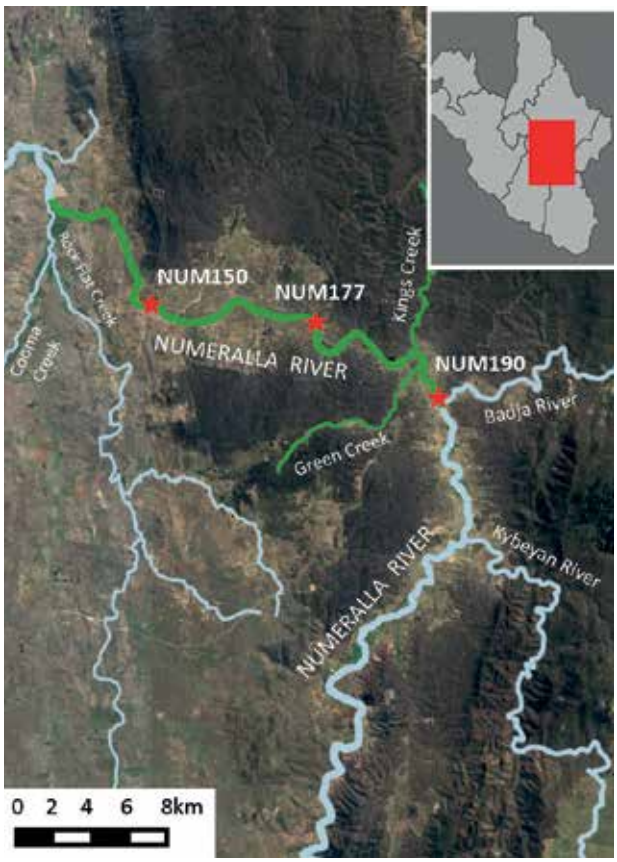
Numeralla Landcare, the Numeralla Fishing Club, landholders and catchment organisations have been working since the 1990s to fence the river from stock, stabilise streambanks, replant native vegetation and reintroduce woody in-stream habitat (re-snagging) which will assist to improve river health. This year's works include remediation of an erosion nick point at site NUM200 by the Numeralla Landcare Group thanks to NSW DPI's Habitat Action Grant program and funded by the NSW Recreational Fishing Trust. The works included a timber log structure which will also improve fish habitat along the river.

Bank stabilisation works by Numeralla Landcare will help reduce erosion and improve habitat

Numeralla River NUM3

Badja River to Cooma Creek confluence

2022 CHIP Result B+ (Good)		
2021 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**23**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Good	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**3**



Reach Facts

Reach network length: approx. 14km
Dominant land uses: Rural and rural residential

This reach includes the Numeralla River from the Badja River to the Cooma Creek confluence. The top half of this reach is flanked with good native vegetation including tall stands of Ribbon gums, fringing ti-trees and bottlebrushes, beds of in-stream reeds and swathes of water milfoil submerged in the river.

The downstream section of the reach has wide floodplains used for dryland cropping and grazing. Here native vegetation has been cleared and historic erosion has contributed large amounts of sand and fine sediment into the river. This reach is in a high priority ACWA catchment where erosion risk was assessed to be very high.

Water quality and river levels are influenced by the inflows of the Badja River at the top of this reach, which are typically of high quality. The reach continues to recover from the impacts of the 2019/20 fires which resulted in high loads of ashen sediment washed in-stream. This sediment can be seen settling on the bottom of the river and increasing turbidity as it is mobilised during flood events.

High flows have reduced in-stream vegetation, scouring reed beds and drowning ti-tree which had been encroaching the channel. This may have contributed to the lower waterbug diversity found in the Autumn survey as there was less available habitat to survey. Despite the lower diversity, both Spring and Autumn surveys included the three key pollution-sensitive waterbug types; mayflies, stoneflies and caddisflies.

Waterwatcher Mike taking an electrical conductivity reading at NUM150

Numeralla River NUM4

Cooma Creek confluence to Murrumbidgee River

2022 CHIP Result B- (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**16**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Good	
Waterbug	**Fair**	**2**
Riparian condition	**Fair**	**2**

Reach Facts

Reach network length: approx. 17km
Dominant land uses: Rural

This reach includes the Numeralla River from the Cooma Creek to its confluence with the Murrumbidgee River. It runs through wide floodplains used for grazing and dryland and irrigated cropping. There is very little native vegetation remaining along this section of the Numeralla River and exotic species such as willows, Box elder (an emerging, but rapidly spreading weed) and poplars dominate the canopy vegetation. Stock are allowed to access the river in some areas.

This reach lies in a priority ACWA catchment where erosion risk was assessed to be very high. Increased turbidity has been observed after high run-off events. In-stream sand deposits are widespread in the river and recent higher flows have brought changes in the channel and scoured the in-stream reed beds. Ash and sediment from the fire-affected Badja River catchment are still being mobilised with a thick layer of grey silt being noted in the low-flow sections of this reach.

Waterbug surveys showed the impacts of the high flow, which can scour habitat and wash populations downstream. The Autumn surveys showed a low diversity and abundance of bugs and contributed to the decline in the overall CHIP score. Both Autumn and Spring were dominated by mayfly nymphs, a pollution-sensitive waterbug which relies on clear, oxygenated water. Electrical conductivity levels also increased from last year and may be a sign of salts and minerals being leached from soils in the catchment. Pesticides and herbicides can also be mobilised in a similar fashion.

High flows have scoured out the floodplain changing the bed of the river channel

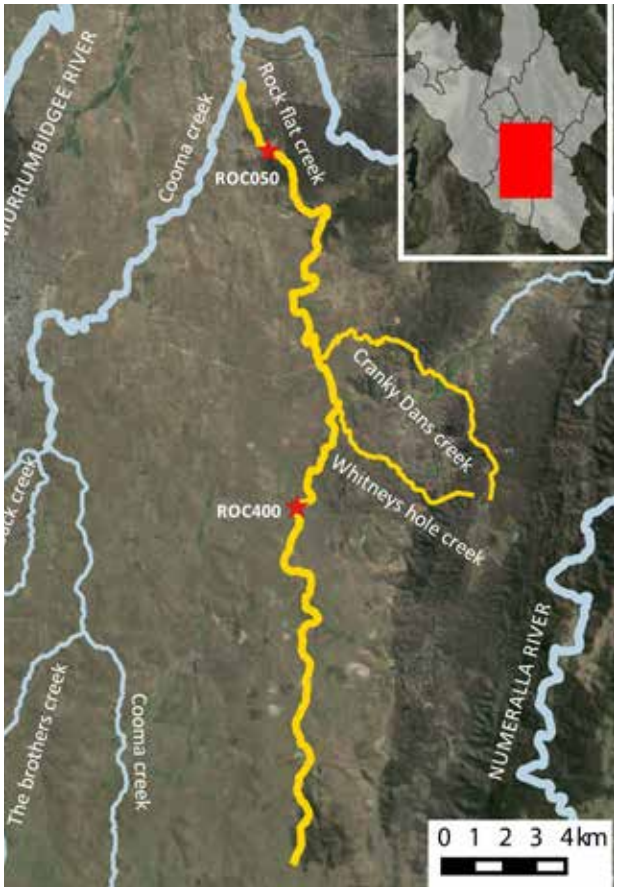
Rock Flat Creek ROC1

Headwaters to Cooma Creek

2022 CHIP Result C- (Fair)

2021 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	**Good**	**21**
pH	Good	
Turbidity	Excellent	
Phosphorus	Fair	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Excellent	
Waterbug	**Poor**	**2**
Riparian condition	**Degraded**	**2**



Reach Facts

Reach network length: approx. 42km
Dominant land uses: Rural

This reach flows through open basalt country, which is used for grazing and cropping agriculture. It includes a high priority ACWA site just downstream of the Cottage Hill Road crossing which is at risk of erosion.

Riparian vegetation along the creek is highly modified with the canopy and shrub layers largely absent, except for some scattered willows. Similarly, there is a lack of in-stream vegetation along this reach, especially where the creek is accessed by stock. Stock impacts that have been observed include increased streambank pugging (trampling) and grazing of what in-stream vegetation is available.

Electrical conductivity levels are influenced by the geology of the catchment and salts and minerals may be mobilised during times of high flows. Electrical conductivity readings in excess of 600µS/cm, well above *degraded* levels, were recorded throughout the year at both sites. It is important to be mindful that inadvertent nutrient or pesticide build up in soils can also be mobilised during such times. Testing conducted by Waterwatcher Mike following rainfall in October revealed phosphous concentrations as high as 0.4mg/L! Mike had to use a special, high range Phosphorous kit to measure it.

Increased nutrients have increased algal growth in the creek and were often noted by Mike, especially at ROC400. Waterbug survey results showed a decline this year compared to last year especially in the Spring survey which yielded a *poor* result due to low diversity. High numbers of mayflies, a pollution-sensitive waterbug, and the more tolerant fly larvae, dominated the sample.

Algal growth in Rock Flat Creek was most likely a result of extremely high phosphorous inputs

Strike-A-Light River STR1

Headwaters to Bredbo River

2022 CHIP Result B- (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**11**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**1**

Reach Facts

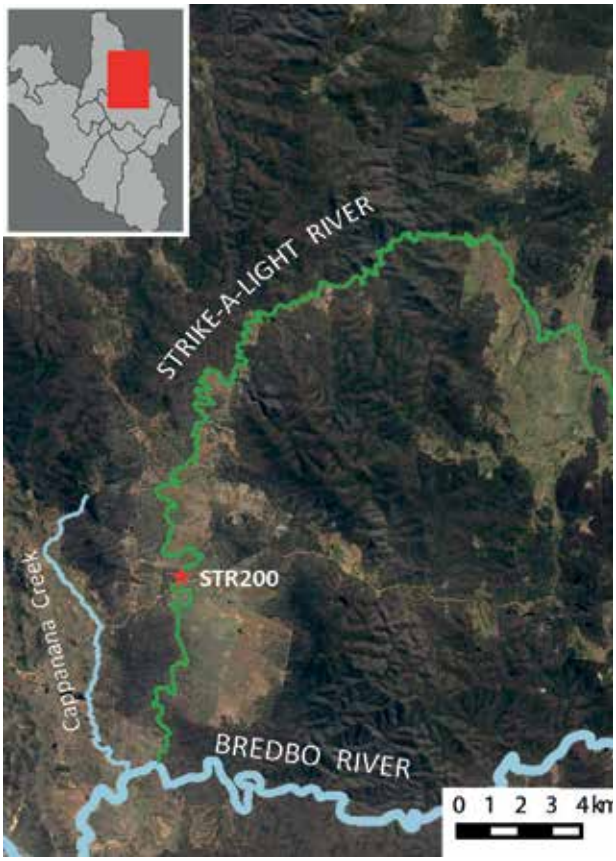
Reach network length: approx. 38km
Dominant land uses: Rural

This reach includes the entire Strike-A-Light River catchment. The catchment includes cleared open country, utilised predominantly for grazing agriculture at the top and bottom ends of the reach. In these areas riparian vegetation has been modified. The middle of the reach is largely native vegetation with intact riparian areas and good in-stream habitat

The river mostly runs clear and usually is free of algae, even during periods of low flow, as seen at the only Waterwatch site on this reach, STR200. As this reach is monitored at only this one site, another volunteer to monitor upstream would greatly enhance our knowledge of this catchment.

The top of the Strike-A-Light River catchment was impacted by the Calabash Fire in February 2020 followed by heavy rains which flushed large amounts of ash off the fireground. Three years on, ashen deposits remain in-stream, affecting phosphorous and turbidity levels, especially during times of higher flow. Turbidity spikes during higher flow events can also indicate the presence of streambank erosion.

Electrical conductivity is often high, which in part can be attributed to the geology in the catchment. High flows in the reach throughout 2022 have seen a significant overall reduction in electrical conductivity, due to fresh, diluting surface flows. This was down from a high of 700µS/cm in 2020 to a range of 130-160µS/cm over much of 2022. Dissolved oxygen also improved and stabilised throughout the year as a result of the regular flushing flows.



Since the 2019/20 fires, turbidity has increased as ashen silt continues to be mobilised downstream

Ginninderra Catchment Facts

Ginninderra Creek begins in the north-western edge of Canberra, in the upper reaches of the Mulligans Flat Nature Reserve, and flows west though the suburbs within Gungahlin and Belconnen. Over 42% of ACT residents live in the Ginninderra Creek catchment making it the most urbanised in the ACT. This is Ngunnawal country.

Ginninderra Creek enters the Murrumbidgee River after passing through the catchment's most significant and best-preserved remnant ecosystem: the Ginninderra Gorge, including the spectacular upper and lower falls. Gooromon Ponds Creek joins Ginninderra Creek near Dunlop and captures runoff from much of the NSW land around Wallaroo, including Halls Creek.

Steady development in Canberra's north has impacted the Ginninderra Creek significantly over the past 30 years, with sediment from development sites and weeds the two most significant issues. The riparian zone for most of the creek 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. This includes Evatt, Umbagong District Park, Macgregor and Dunlop.

Ginninderra Waterwatch Volunteers have been monitoring this catchment since 1997.

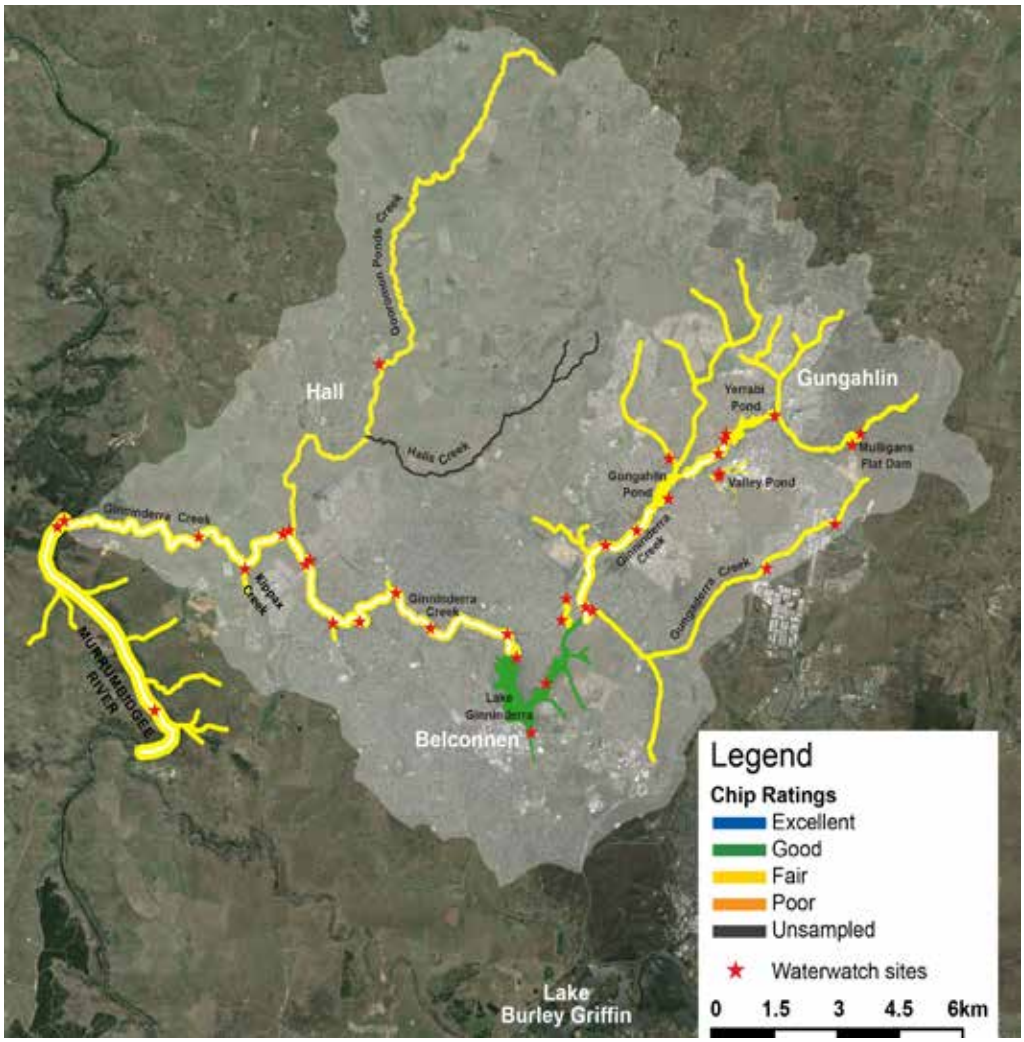
Ginninderra Catchment Health Summary

Once again, the Ginninderra Creek catchment saw above-average rainfall in 2022. This created high flows throughout most of the year, particularly in late Winter and Spring, producing mixed results across the catchment. Four reaches saw a decline in CHIP score while three reaches had improved scores. Despite these shifts in individual reaches, overall the catchment attained fairly uniform scores and saw little change from 2021, with the remaining eight reaches gaining the same score and all reaches falling within the B- to C- range. This could reflect the conflicting positive and negative effects of high flows in urbanised environments, constraining further improvement in this catchment despite the plentiful rain.

Both for the reaches with improvements and those with declines in overall CHIP scores, the strongest driver was a change in waterbug diversity. High flows and raised water levels can scour stream channels and submerge the in-stream and edging vegetation that provides important waterbug habitat, as well as potentially flushing bug populations downstream. The reaches that saw improvements in their waterbug scores included Lake Ginninderra and Gungahlin Pond, large stable waterbodies that may be less susceptible to these effects.

Of the reaches that saw poorer scores than last year, three saw worsening nutrient levels – particularly increases in nitrates – which were also noted in several reaches whose overall scores did not change. This is not a surprising outcome for a wet year in such an urbanised catchment, as organic matter and pollutants build up quickly on the roads and gutters, from where they are efficiently washed into the waterways via the stormwater system. That said, it doesn't need to be inevitable consequence of urbanisation. By improving riparian structure and complexity throughout the urban landscape the catchment's ability to capture nutrients before they enter the waterways can be improved.

Other small shifts in water quality were noted across the catchment, not always resulting in a change in the overall score for a reach. Dissolved oxygen, for example, saw a general improvement across seven reaches. A number of wetland reaches, however, experienced occasional supersaturated levels of dissolved oxygen, often associated with elevated nutrient inputs and algae outbreaks in the warmer months.



Ginninderra Creek GIN1

Crace to Giralang Pond

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**33**
pH	Excellent	
Turbidity	Good	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Fair	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**

Reach Facts

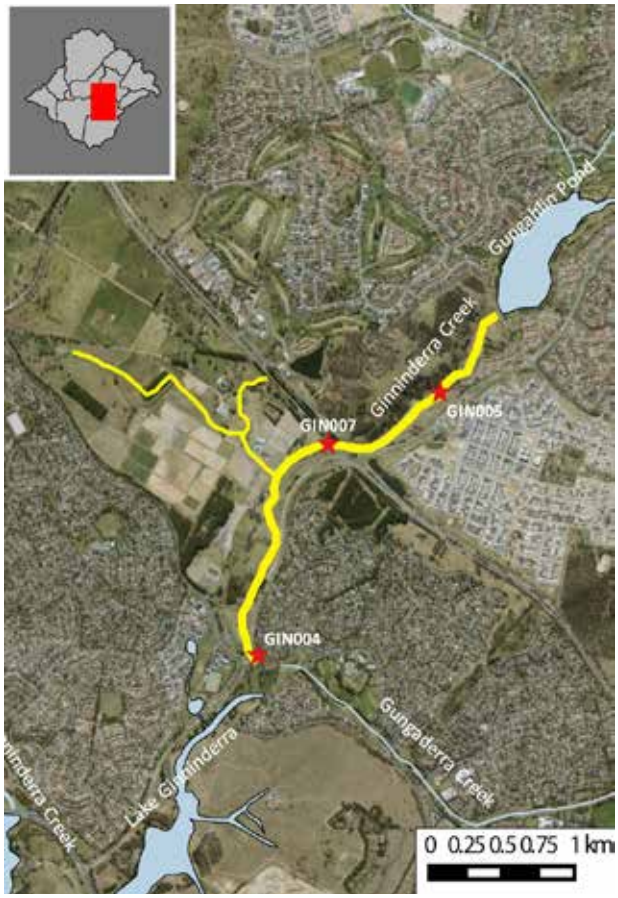
Reach network length: approx. 5km
Dominant land uses: Urban

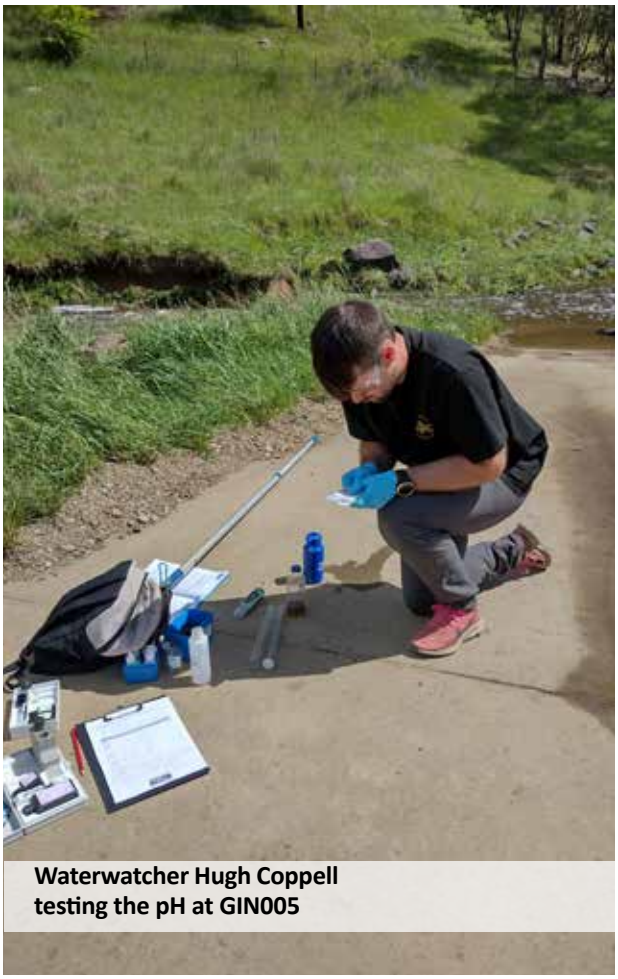
Starting at the outflow of Gungahlin Pond this reach includes the stormwater inflow from Nicholls and Crace. The middle of the reach receives runoff from the CSIRO field test facility while the downstream section flows through the Old Palmerville township historic site 12 and Landcare Forest. The end point for this reach is Giralang Pond which is the only small stream pond present on Ginninderra Creek.

This section of the catchment is highly urbanised. Urbanised areas have a high proportion of impervious surfaces, such as roads and concrete drains, which increases runoff, warms the water and can add lots of urban pollutants to the waterways. Electrical conductivity can often be high as a result of these pollutants with *degraded* levels of >400µS/cm being detected here on at least six occasions over the course of 2022.

The areas adjacent to Ginninderra Creek in this reach have good groundcover and little sign of erosion. It also has plenty of in-stream reeds but, throughout 2022, Waterwatchers noted that high flows and flooding events had flattened or broken the reeds at two of the Waterwatch sites. Fluctuating water levels also resulted in deposits of accumulated sediment in-stream and exposed muddy banks. The absence of large trees and shrubs also means the creek can be quite exposed, resulting in a *poor* score for riparian condition.

Feral fish such as European carp, Redfin perch and Eastern gambusia are frequently sighted throughout this reach.





Waterwatcher Hugh Coppell testing the pH at GIN005

Ginninderra Creek GIN2

Lake Ginninderra

2022 CHIP Result B- (Good)		
2021 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**31**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Good	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**

Reach Facts

Reach network length: approx. 9km
Dominant land uses: Urban

Starting below Giralang Pond and finishing at the Lake Ginninderra Dam wall, this reach covers the main city centre of Belconnen. The main inflow is from Ginninderra Creek from the north-east, which includes the new suburb of Lawson. The other inflow is at the southern end of the lake and is mostly urban stormwater that flows into the recently redeveloped Eastern Valley Way wetland.

The riparian zone in this area of Lake Ginninderra is mainly comprised of grasses and shrubs, with many being introduced species. There is little available habitat for wildlife along the edges of the lake and there is scope here to add complexity to areas that are not required to be neat and tidy to allow for visitor access. Rubbish continues to be a problem throughout this reach, and a build-up of deciduous leaves was also noted. This can lead to increased nutrients in the system and cause issues with Blue-green algae.

Water quality improved on last year, driven by more stable dissolved oxygen results. Waterbug scores also went up with the presence of a number of types of mayfly nymphs and caddisfly larvae; both considered to be pollution-sensitive. That said, pollution-tolerant types such as water boatman and glass shrimp, still dominated the numbers.

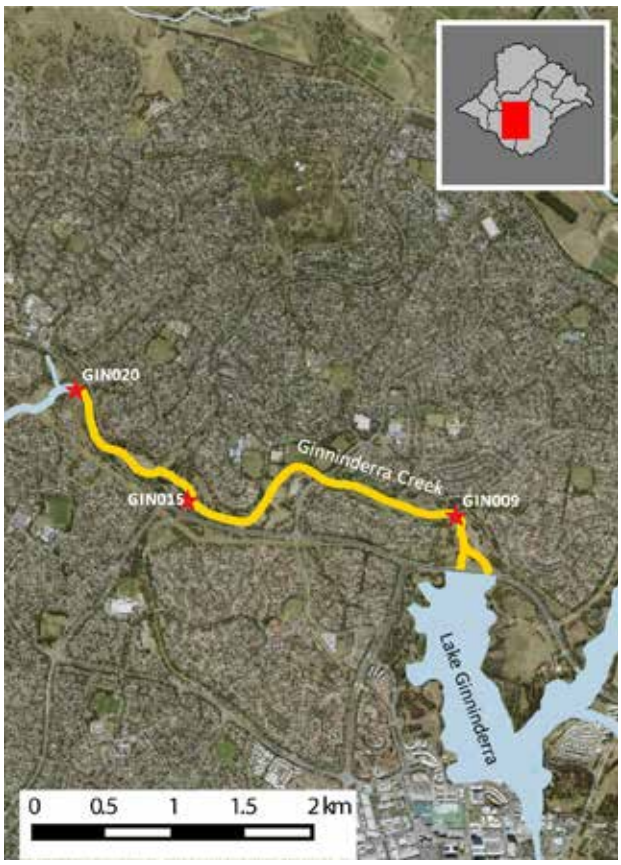
Rakali (native Water rats) were sighted several times during 2022, with one seen repeatedly during the Autumn bug survey at GIN013 near the dam wall, and another by Waterwatcher Shane at GIN008 in December.

Univeristy of Canberra student, Ayan Chatterjee helping out with waterbug surveys at GIN013

Ginninderra Creek GIN3

Dam wall to Ginninderra Drive

2022 CHIP Result C (Fair)		
2021 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**31**
pH	Excellent	
Turbidity	Excellent	
Total Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Poor	
Waterbug	**Poor**	**2**
Riparian condition	**Poor**	**3**



Reach Facts

Reach network length: approx. 4km
Dominant land uses: Urban

This reach begins below the Lake Ginninderra spillway and sits entirely within established suburbs with high urban stormwater inflow. The reach has good reed cover and wide, well-grassed buffer zones in most areas.

Even though there is a moderate presence of trees along the edge of Ginninderra Creek in this section, the majority are introduced species like poplars and willows. These trees drop large amounts of leaf litter into the waterways in Autumn, choking some areas of the creek and causing spikes in nutrients. There has been significant effort over recent years here to replace poplars with native species. It will take some years for the benefit of this management strategy to be reflected in the riparian condition scores.

High water levels and vigorous vegetation growth throughout 2022 made it difficult for volunteers to access their usual sampling sites. Waterwatchers also noted substantial erosion, and a tree that fell into the creek during the very wet month of August. Despite this turbidity remained low, possibly thanks to the high flows flushing through the reach.

Electrical conductivity can be high here, as is typical of many urbanised streams where pollutants from roads and drains are being washed straight into the system. Electrical conductivity readings from this reach were regularly in the *poor* category of >200µS/cm. Waterwatcher Ana noticed a strange spike of 690µS/cm in February at GIN009 while also noting '*the water had an oily layer on top*, seemed viscous and stagnant'. On a better note, Ana also observed a Rakali (native Water rat) at her site in October.

The high flows and artwork at GIN020 in October (photo: Trevor and Ann Harvey)

Ginninderra Creek GIN4

Ginninderra Creek at Umbagong District Park

2022 CHIP Result C+ (Fair)

2021 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	**Good**	**34**
pH	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**4**
Riparian condition	**Poor**	**3**

Reach Facts

Reach network length: approx. 6km
Dominant land uses: Urban

This reach starts downstream of Ginninderra Drive and flows through the Umbagong District Park, ending at the confluence with Gooromon Pond Creek. It also includes Jarramlee Pond, a stormwater pond which naturally treats the stormwater coming from the Dunlop neighborhood. Jarramlee Pond is a great habitat for aquatic birds, turtles and frogs.

The reach is well vegetated with a good native riparian zone and wide grassland buffers in many sections. Previous creek restoration projects by the Ginninderra Catchment Group and Umbagong and Macgregor Landcare Groups have improved riparian condition and water quality.

Another wet year saw the high flows in this reach continue, with sediment deposits apparent after flooding and frequent observations of elevated turbidity. Two invasive fish species (Eastern gambusia and Oriental weatherloach) were noted during the Autumn waterbug survey, while Yellow-tailed Black Cockatoos were more welcome visitors in Spring. Waterwatchers kept up their mighty efforts in removing litter from the creek each month.

Water quality worsened slightly in 2022 driven mainly by fluctuating dissolved oxygen levels. Results regularly fell into the *degraded* category of <78% saturation and readings in Jaramlee Pond (STW005) got as low as 44%.

Jarramlee Pond was part of the urban turtle project run by Ginninderra Catchment Group that wrapped up at the end of 2021. Volunteers continue to keep an eye out for turtles nesting here in order to protect the nests against predation by foxes.

Volunteers helping to measure turtles at Jarramlee Pond (STW005)

Ginninderra Creek GIN5

Gooromon Ponds Creek confluence to Ginninderra Falls Gorge

2022 CHIP Result C- (Fair)		
2021 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**8**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Poor	
Electrical Conductivity	Poor	
Dissolved Oxygen	Good	
Waterbug	**Degraded**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 7km
Dominant land uses: Urban/Rural Fringe

This reach runs from the confluence with Gooromon Ponds Creek to the rural properties around Kilby Homestead. The upper section has significant bank erosion and the lower section runs through sheep and cattle farms.

This year the riparian vegetation scores remained at *poor* and *degraded*, with many emerging willows observed growing along the river bank as well as evidence of continued bank erosion. Ginninderra Catchment Group, Greening Australia and the Riverview group have undertaken willow removal and native regeneration work in the midsection of the reach, which will eventually provide more habitat for small vertebrates such as frogs and lizards. Five Eastern water dragons were spotted at the Kilby Homestead (GIN040) during water sampling in November.

The diversity of waterbugs was down, with only six and seven different Orders being recorded across the two surveys compared to ten in 2021. Unsurprisingly for such a wet year, flows were high during the waterbug surveys which may have been one reason for the reduced diversity. That said, it was pleasing to see some variety within the more pollution-sensitive types such as mayflies where the Family Leptophlebiidae were detected here for the first time. This particularly type of mayfly tends to disappear in urban streams so this was a welcome find. Overall, however, it was pollution-tolerant water boatman (Order: Hemiptera) that dominated the numbers, with hundreds being detected in both surveys.

Ginninderra Creek at GIN040 experienced extensive riparian growth after a wet year

Ginninderra Creek GIN6

Ginninderra Falls Gorge to Murrumbidgee River confluence

2022 CHIP Result C (Fair)		
2021 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**4**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Fair	
Electrical Conductivity	Poor	
Dissolved Oxygen	Good	
Waterbug	**Degraded**	**2**
Riparian condition	**Fair**	**1**

Reach Facts

Reach network length: approx. 3km
Dominant land uses: Conservation

This reach comprises the high conservation value area of Ginninderra Falls and Ginninderra Gorge. It is comprised of large areas of native woodlands and shrubs. The rough terrain and inaccessible nature of the downstream section contributes to its complex structure. This section has the best riparian habitat in the Ginninderra catchment. Ginninderra Falls also represents an important Ngunnawal cultural site, known to host significant Indigenous ceremonies and male initiations.

Although the riparian vegetation here is well represented by mature Casuarinas and Eucalypts, regeneration is not particularly evident along the creek. Despite the good vegetation cover, the upstream stressors such as urbanisation and farming can still be felt downstream, with elevated electrical conductivity readings (~350µS/cm) regularly detected.

The frequent rainfall resulted in medium to high flows at GIN050 throughout 2022. The flows brought with them increased nutrient levels, with both nitrates and phosphorous higher than the previous year. Waterbug results were also poorer with low diversity being an issue, especially in Autumn when only three Orders were observed. There is limited riverbank vegetation for waterbugs and the creek bed in this section is mainly rocky with very little in-stream vegetation. The high flows can scour out Casuarina leaves and other potential habitat from the substrate and possibly contribute to the reduced diversity.

Ginninderra Creek at GIN050 saw high flows throughout the year

Gooromon Ponds Creek GOO1

Headwaters to confluence with Ginninderra Creek

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**11**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Fair	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**2**

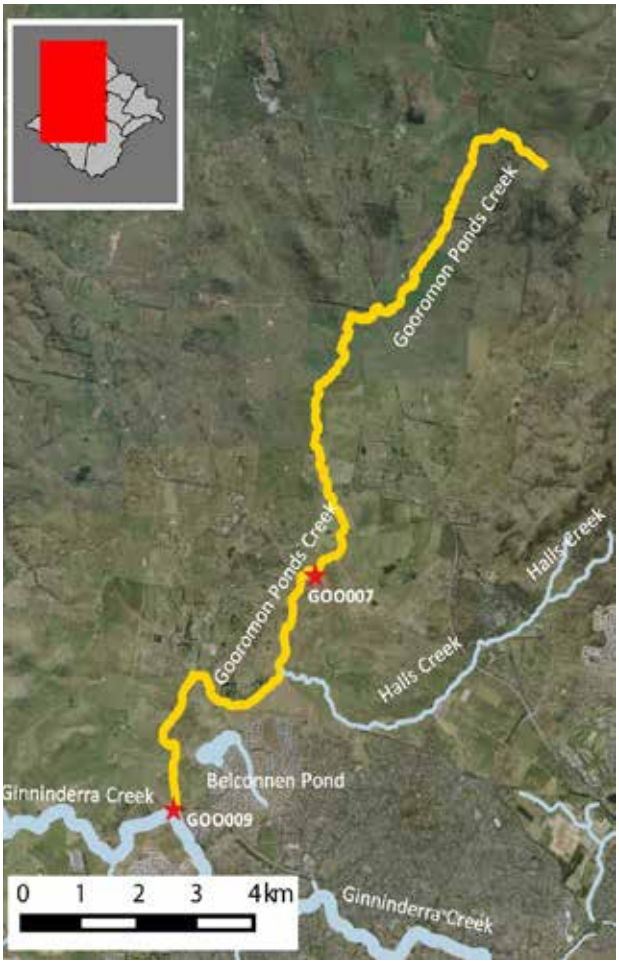
Reach Facts

Reach network length: approx. 17km
Dominant land uses: Rural

Flowing through the rural land surrounding Hall and Wallaroo, the Gooromon Ponds Creek is a mostly ephemeral system with intermittent pools. This creek contains sections of moderate erosion and extensive areas with low habitat value.

This reach represents a typically cleared and modified grazing country. Ground cover is relatively intact however exotic pasture grasses dominate, mid-storey and canopy species are scarce and mostly exotic. The ground layer has also been simplified with limited habitat features such as fallen logs and native tussock grasses. The lack of native canopy cover and regeneration, and consequently no leaf litter, all contribute to reduced soil stability and can result in erosion.

Electrical conductivity is often elevated in this reach. Readings as high as 1360µS/cm were measured in March when the water levels were noted as low. Such high concentrations are most likely influenced by both the geology of the region and historical land use. The water quality score declined in 2022 due to phosphorous levels at 0.07mg/L when the flows were high in November. The overall CHIP score improved, however, due to increased waterbug diversity compared to the previous year. Pollution-sensitive stoneflies were observed in the Spring waterbug surveys at the confluence (GOO009), for the first time since sampling at this site began. This is a sign that three, consecutive wet years are having a positive effect on this small, rural stream.



This small stonefly was a good sign for the health of Gooromon Ponds Creek

Gungaderra Creek GDC1

Gungahlin to Giralang Pond

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**Survey**
Water quality	**Good**	**27**
pH	Excellent	
Turbidity	Good	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Fair	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**

Reach Facts

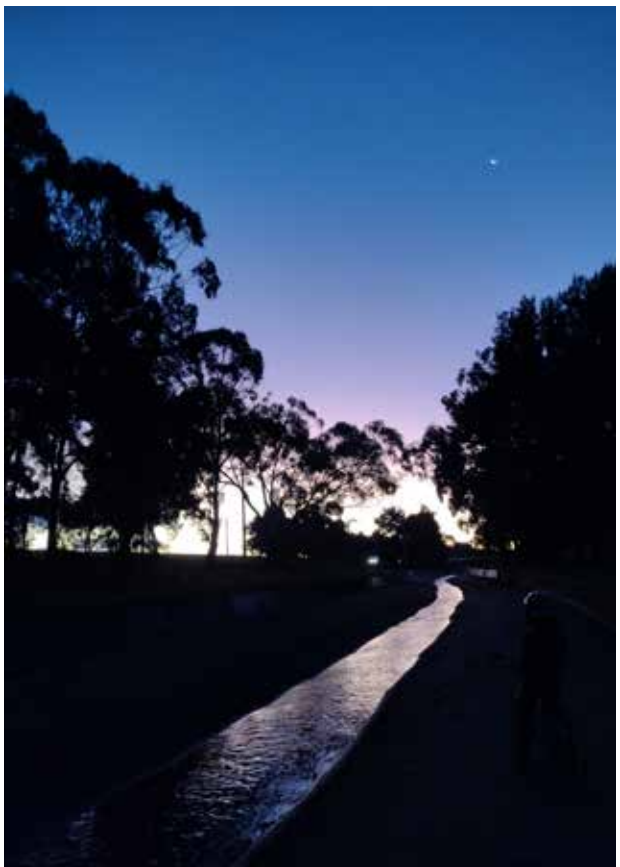
Reach network length: approx. 10km
Dominant land uses: Urban

This reach 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. It also includes a stormwater channel from the University of Canberra and Canberra Stadium and has moderate urban stormwater inflow.

This reach displays a marked elevation in electrical conductivity levels between the upstream (GDC010) and downstream site (STW001), showing the cumulative effects of water running through the urban landscape, travelling over lots of impermeable surfaces such as concrete drains and flushing urban pollutants into our waterways.

In addition to these concrete stormwater drains, the lack of native canopy and understorey plus a dominance of exotic vegetation in this reach, account for its *poor* riparian vegetation assessment score. Volunteers have planted trees and shrubs to improve the width of riparian habitat along Giralang Pond in collaboration with the Ginninderra Catchment Group and ACT Government.

The waterbug diversity was *good* in both the Autumn and Spring bug surveys with eight and ten Orders detected respectively. That said the dominant Orders found in both surveys were pollution-tolerant types such as fly larvae (Order: Diptera) and water boatman (Order: Hemiptera). It was noted during the Spring survey that a lot of silt had been deposited into Giralang Pond following the flooding flows throughout Winter.



Gungaderra Creek stormwater channel directly upstream of STW001 (photo: S.de Oliveira)

Gungahlin Pond GUN2

Headwaters of Ginninderra Creek north arm to Gungahlin Pond

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**30**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**

Reach Facts

Reach network length: approx. 6km
Dominant land uses: Urban/Rural Fringe

The north arm of Ginninderra Creek originates in the rural lands surrounding the northern suburbs of Gungahlin and forms the east arm in Gungahlin Pond. The upper section is mostly ephemeral drainage lines disconnected by stock dams before flowing into the sediment control pond of Gungahlin. This reach receives a high inflow of urban stormwater from surrounding suburbs and new developing suburbs such as Taylor and Moncrieff.

Limited sections of the riparian zone score well for their habitat values, with some significant native canopy evident. Exotic species, however, with limited habitat values, dominate the edge of Gungahlin Pond. These highly urbanised areas are regularly mowed to the water's edge, making the regeneration of native plants difficult. On the other hand, in-stream vegetation in the form of reeds and Ribbon weed are present throughout the reach, and abundant in some areas, providing good habitat for frogs, turtles and waterbugs.

While the two sites on Ginninderra Creek and Gungahlin Pond had the occasional low dissolved oxygen results and elevated phosphorous, it was the stormwater pond (STW006) that once again showed the most concerning water quality results. Dissolved oxygen values were supersaturated (up to 140%), there were spikes in nutrients, and electrical conductivity reached concentrations as high as 1010µS/cm which is more than twice the concentration that's considered *degraded*. It is possible that the increased nutrient levels carried by the frequent rainfall in 2022 were in part responsible for the high growth in algae noted by Waterwatcher Bruce.

University of Canberra student, Bailey, sampling the Ribbon weed for waterbugs at Gungahlin Pond

Kippax Creek KIP1

Headwaters to Ginninderra Creek confluence

2022 CHIP Result C (Fair)		
2021 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**12**
pH	Excellent	
Turbidity	Good	
Phosphorus	Poor	
Nitrate	Degraded	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Fair	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**1**

Reach Facts

Reach network length: approx. 2km
Dominant land uses: Urban

Kippax Creek is now mostly a system of stormwater drains and drainage lines. The remaining unmodified creek section is only a 400m stretch from the last gross pollutant trap to the confluence with Ginninderra Creek. This reach offers a great opportunity to study the impacts of a catchment that is heavily urbanised with limited water quality improvement infrastructure. The lower section sits within an important native grassland at the Umbagong District Park.

Despite its *poor* riparian score, a high diversity of in-stream and edge vegetation persist on the creek's downstream section. Waterwatcher Lesley Harland noted eight species of water plants, including five native species during February sampling.

High levels of phosphorous and nitrates were detected throughout 2022. These are washed into the system with the increased flows, capturing pollution, litter and fertilisers off suburbs, streets and sporting ovals.

Waterbug diversity in this reach was high with 13 different Orders recorded in the Autumn survey. While they were mostly pollution-tolerant bugs, there was quite a lot of variety within the Orders particularly for dragonflies and damselfies (Odonata) and five different types of 'true bugs' such as waterboatmen (Hemiptera).

An Oriental weatherloach was also recorded during Autumn waterbug surveys. An invasive fish, Oriental weatherloach are extremely tolerant of poor water quality such as low dissolved oxygen as they are able to swallow air and absorb oxygen through their intestine.

Volunteer Suzanne helping out with the Autumn watebug survey on Kippax Creek

McKellar Wetlands MCW1

Designed habitat wetland system, McKellar

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**22**
pH	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 500m
Dominant land uses: Urban

The two McKellar wetlands are designed primarily for frog habitat, and secondly for recreation. This is evident in the significant reed growth in both wetlands, and the connecting channel linking them, which is heavily vegetated to facilitate animals such as frogs and turtles to move through. It is situated in an established suburb, with nutrient inputs derived from sources such as gardening and cleaning as well as leaves from street trees.

The *poor* riparian condition score is influenced by the low levels of canopy and understorey present. Ground cover, however, is considered relatively healthy with a high number of native tussock grasses. The area surrounding the wetlands in this reach is typical of many urbanised areas in Canberra, with manicured grasses and low numbers of trees. The riparian assessment does not account for all of the aforementioned good in-stream habitat.

Turbidity and electrical conductivity in the reach were both higher than usual throughout most of 2022, especially in the lower pond (MCW001) which had major roadworks nearby for several months. There were also spikes in nutrients observed, generally following periods of wet weather when water levels were high. However, a *fair* diversity of waterbugs was recorded with ten different Orders present in both the Autumn and Spring surveys.

A variety of waterbirds were spotted in the wetlands throughout the year, including Yellow-billed spoonbills and a family of Black swans.

A family of Black swans at McKellar Wetlands (photo: L. Wensing)

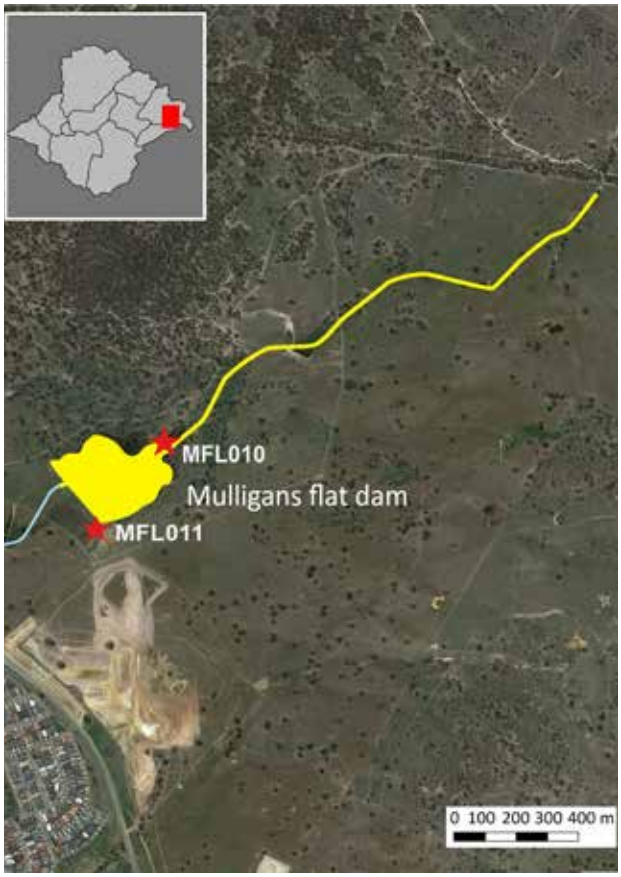
Mulligan's Flat Dam MFL1

Headwaters of Ginninderra Creek to Mulligan's Flat Dam

2022 CHIP Result C+ (Fair)

2021 CHIP Result B- (Good)

Parameter	Rating	No. Survey
Water quality	**Good**	**19**
pH	Good	
Turbidity	Fair	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Waterbug	**Poor**	**2**
Riparian condition	**Fair**	**2**



Reach Facts

Reach network length: approx. 2km
Dominant land uses: Conservation

Mulligan's Flat Dam was originally an old farm dam, now repurposed as an ecological habitat. The Mulligan's Flat Woodland Sanctuary was established in 1995 to protect the Box-gum grassy woodlands and associated fauna in the Gungahlin area. The Dam is normally filled with rainwater that is filtered off the surrounding landscape, and is a popular spot for bird watchers. The site plays host to a number of conservation projects and the sanctuary is protected by a predator-proof fence.

Mulligan's Flat's main habitat is grasslands and there are high levels of native ground cover vegetation which promote soil stability and provide habitat for small vertebrates, such as frogs, lizards and the New Holland mouse. Most of the secondary grassland communities in Mulligans Flat were created by the early farmers who cleared woodland areas in the region.

The dam remained full to overflowing throughout the wet Winter and Spring of 2022. Turbidity was elevated and waterbug diversity was lower than in previous years, driving down the overall CHIP score.

Invasive Eastern gambusia (commonly called mosquito fish) were found in the dam during the April waterbug survey, the first time they have been detected here since sampling began in 2017. These fish were initially introduced during the 1920s because of their reputation for mosquito control. Since then, however, their ability to control mosquito larvae has been shown to be no greater than that of small native fish that feed on insects.

The overflow point at Mulligan's Flat Dam was spilling throughout Winter and Spring in 2022

Murrumbidgee River CMM11

Molonglo River confluence to Ginninderra Creek confluence

2022 CHIP Result C (Fair)		
2021 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**8**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Fair	
Electrical Conductivity	Good	
Dissolved Oxygen	Good	
Waterbug	**Degraded**	**2**
Riparian condition	**Poor**	**2**

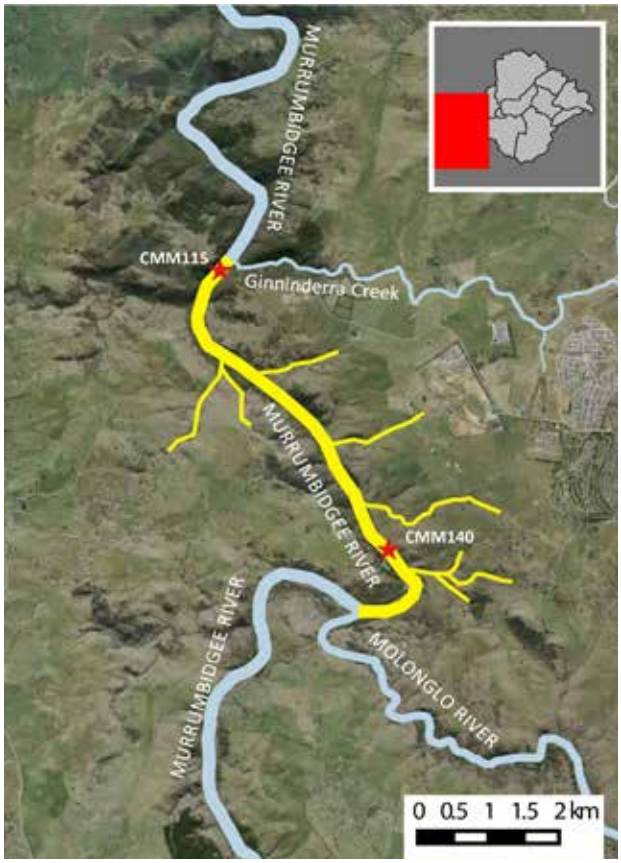
Reach Facts

Reach network length: approx. 7.1km
Dominant land uses: Conservation, rural

Starting below the confluence of the Molonglo River and finishing at the confluence with Ginninderra Creek, this reach includes mostly rural land and part of the Murrumbidgee River Reserve. Some sections of gorge country are also included and the upper section of the reach receives the outflow from the Lower Molonglo Water Quality Control Centre (LMWQCC).

A number of high nitrate readings have been recorded in this reach over the past couple of years, particularly during the low flows of 2018 and 2019. This can most likely be attributed to discharges from the LMWQCC as Waterwatch sites on the Murrumbidgee River above the Molonglo River confluence have indicated little to no nitrate present. Nitirate levels were slightly elevated in 2022, with *degraded* levels of 3-4mg/L being detected on three occasions.

After showing improvements in 2021, this year saw a decline in water quality and waterbug scores despite, or possibly because of, the continued high flows. Only five waterbug Orders were detected at the Autumn and Spring surveys. Slow moving waterbugs, and those that populate by migrating through the water, such as snails and flatworms, were missing from surveys, likely washed downstream by turbulent high flow events. Fast moving waterbugs that can repopulate water bodies by air after high flow events, such as whirligig beetles, waterstriders and backswimmers were dominant. Though it was encouraging that pollution-sensitive Mayflies (Family: Leptophlebiidae) were detected in Autumn.



Waterwatcher Bridie sampling water quality at CMM115

The Valley Ponds GUN1

Wetland to Gungahlin Town Centre

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**13**
pH	Good	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Fair	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 2km
Dominant land uses: Urban

Originally an old farm dam and artificial seepage grassland, this site was a unique habitat for this catchment. The site has since been redeveloped into an urban wetland for the Gungahlin town centre and parts of Palmerston. It is now a high-quality education and recreation wetland.

With the original pond possessing a high diversity of native aquatic plants and edge vegetation, riparian plant and seed core samples were taken in 2012 and were replanted after construction of the wetland. A decade on, the wetland now displays an impressive array of aquatic and riparian vegetation, including Rush (*Juncus*), Spikerush (*Eleocharis*) and Milfoil (*Myriophllum*) species. Despite this, riparian condition scores remain *poor*. Mature native mid-storey and canopy species are largely absent but as the planted Casuarina and Eucalyptus species mature and regenerate, riparian condition scores should improve.

Phosphorous levels can be an issue here, feeding algae outbreaks which then in turn contribute to supersaturated dissolved oxygen levels (as high at 131% in January 2022). Electrical conductivity continues to be an issue at this pond with concentrations as high as 1160µS/cm in July. Electrical conductivity can be high in urban areas due to a build-up in pollutants but this site has some of the highest readings recorded for any urban catchment.

The Bunyip Cubs and Yowie Pack from Birralee Scout Group regurlarly help out with the Autumn and Spring waterbug surveys. The local Waterwatch volunteers regularly observe Swamp hens, Black swans and cygnets and the occasional Pelican in the wetland.

Education activity with SEE-Change at the Valley Ponds (photo: D.Johnston)

Yerrabi Pond YER1

Headwaters of Ginninderra Creek to Yerrabi Dam Wall

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**17**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Fair	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 10km
Dominant land uses: Urban/Rural Fringe

The east arm of Ginninderra Creek originates in the rural landscape surrounding the northern suburbs of Gungahlin. It includes the former rural property, now significant woodland reserve, of Mulligans Flat Woodland Sanctuary. The upper section is mostly ephemeral creeks, interspersed by stock dams. The reach receives a moderate inflow of urban stormwater from surrounding suburbs.

The riparian vegetation score is largely influenced by the site near the outflow of Yerrabi Pond, which backs onto a concrete channel connected to a main road. The other areas are mainly comprised of exotic species, especially in regards to the groundcover. A few scattered trees do occur, with Casuarinas being the most representative native tree.

Feral fish such as Eastern gambusia and European carp are regularly sighted at Yerrabi Pond although it is also stocked with Murray cod and Golden perch fingerlings by the ACT Government's Conservation Research Branch.

A large algal bloom across Yerrabi Pond in December was the likely driver of supersaturated levels of dissolved oxygen (157% saturation) along with strongly alkaline pH (9) near the southern inflow (YER001). Waterwatcher Connor Skeels conducted the dissolved oxygen test twice as he had never recorded an oxygen reading like that before. Phosphorus levels as high as 0.07mg/l were recorded in the months leading up to this event on the back of high inflows. It's possible that the increased amount of nutrients were in part responsible for the high growth of algae and this, in turn, produced high amounts of oxygen as a byproduct of photosynthesis.

A large algal outbreak in December was affecting water quality at Yerrabi Pond (photo: C.Skeels)

Molonglo Catchment Facts

The Molonglo catchment extends from the Murrumbidgee River, just downstream of Uriarra Crossing, to the headwaters of the Molonglo and Queanbeyan Rivers and Jerrabomberra Creek, an area of about 2,000 km2. This is Ngarigo and Ngunnawal country.

This diverse catchment includes the urban areas of Queanbeyan and inner Canberra, villages such as Captains Flat and rural residential areas and farmland including Burra, Royalla and Carwoola. There is new residential development at Googong and Jumping Creek, southeast of Queanbeyan, and 'Poplars', near Jerrabomberra. New suburbs of Whitlam and Denman Prospect continue to expand around the lower Molonglo River in the Molonglo Valley. Non-residential areas include native and pine forests, wetlands, national parks and the foreshores of Googong Dam, which is a drinking water source for Canberra and Queanbeyan.

Lake Burley Griffin is on the Molonglo River and collects stormwater and runoff from Queanbeyan, much of north Canberra and Fyshwick industrial area, as well as treated output from the Queanbeyan sewerage treatment plant. Lake Burley Griffin water quality is monitored by the National Capital Authority and information can be found at https://www.nca.gov.au/environment/lake-burley-griffin/water-quality.

The Molonglo catchment has a large population with urban waterways flowing predominantly through concrete channels. This is a key issue for urban catchments where there is little riparian vegetation and habitat to slow down flows and capture and absorb nutrients and sediments.

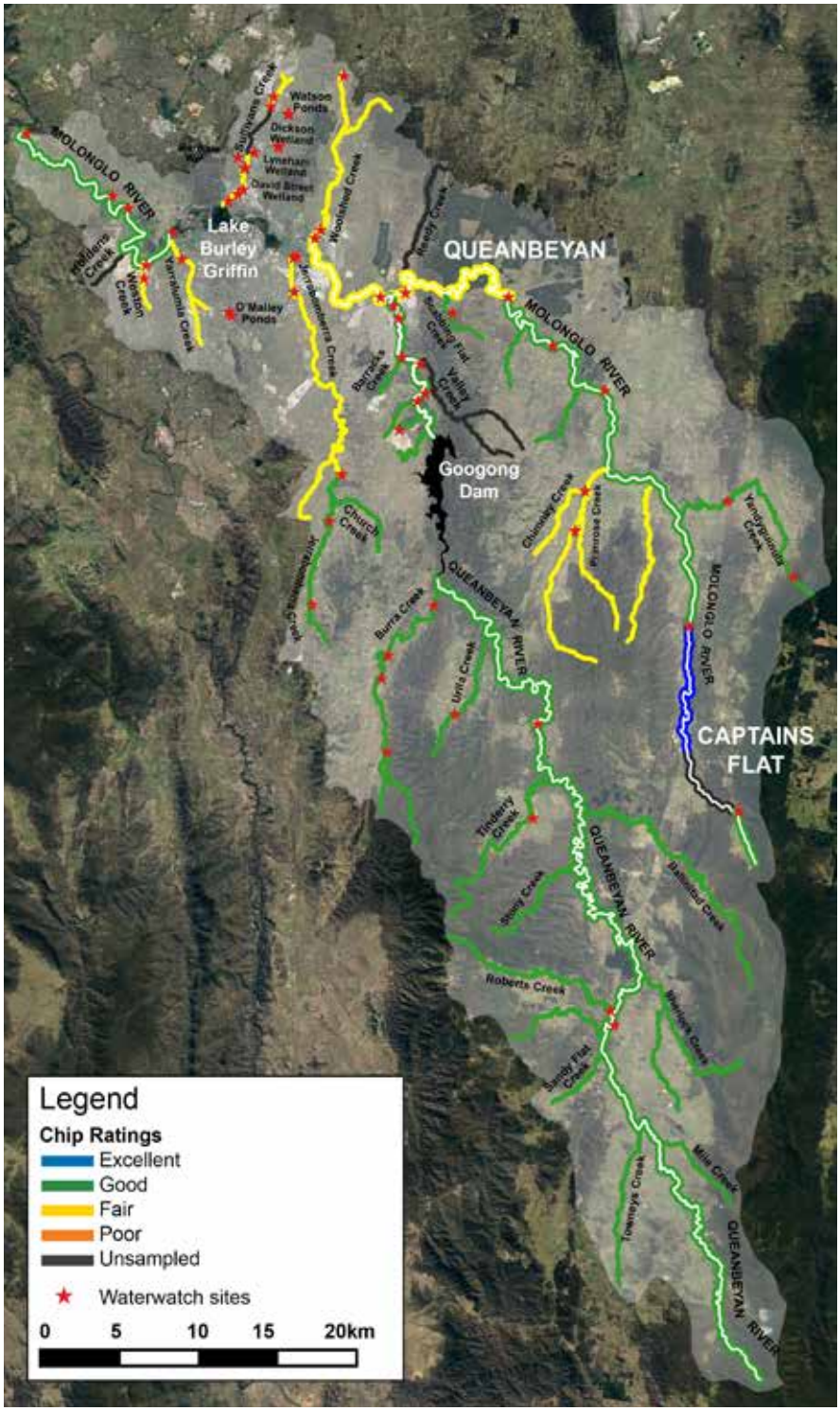
The Molonglo catchment formed a major part of the ACT Government's Healthy Waterways program. Ten projects were completed, including the installation of raingardens, wetlands, and ponds throughout Canberra urban areas. These urban wetlands help to filter and treat polluted run-off before they reach our lakes and rivers.

Though water quality across the Molonglo catchment is generally good, it is the highly urbanised reaches and rural creeks with largely cleared vegetation, that are in the poorest overall condition.

Molonglo Catchment Health Summary

After three years of above average rainfall and declining water quality, results are finally starting to turn around in the Molonglo catchment. Eight reaches saw an improved overall score, with 15 remaining the same, and only two declining. Catchments with large urban and industrial areas generally see a decline in water quality in wetter years as increased run-off washes nutrients, minerals and pollution off roads and suburbs into waterways. After three years of La Niña, saturated soils, recharged groundwater, and full springs have left catchment water levels more responsive to rainfall, increasing available surface water and diluting nutrients as well as salts and minerals entering our waterways. Of the eight improved reaches, six saw improvements due to water quality.

Waterbugs also saw an improvement this year. Seven of the eight reaches that fared better in 2022 did in part due to an overall increase in aquatic macroinvertebrate diversity. Stoneflies were a big mover, turning up at 13 of 26 reaches, up from nine last year. This included being detected at MOL7 for the first time. Stonefly nymphs are very sensitive to poor water quality and prefer rocky sections of fast-flowing riffle. High flows help to flush sand and sediment from cobbles, increasing potential habitat. Other Orders known to be sensitive to poor water quality, such as mayflies, and caddisflies, were present in part at all but two reaches throughout the year. The steeper, upland catchment that encompasses QUE1 was the exception here. The consistent high energy flows and flooding conditions submerged habitat and flushed away many slow-moving and generally more tolerant waterbug Orders. This caused a drop in overall diversity and reduced the reach's overall grade.



Erosion continues to be an issue in 2022 with smaller, tributary creeks getting hit the hardest. Reports of extreme bank erosion are evident, particularly downstream of new and existing urban development. The greater amount of impermeable surface in these areas results in flashy and increased flows that impact riparian areas with poor structure. Tributaries where erosion was noted include Deep, Weston, Primrose, Yarralumla and Googong creeks. All these creeks except Primrose are downstream of urban development and all but Googong Creek received a poor riparian condition score.

Over 550 water quality surveys were completed this year, as well as 51 waterbug surveys and 12 riparian condition assessments. Thank you to all our dedicated volunteers for their time and hard work.

Banksia Street Wetland SUW2

Sullivans Creek in O'Connor

2022 CHIP Result B- (Good)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**12**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Fair**	**1**

Reach Facts

Reach network length: approx. 0.2Ha
Dominant land uses: Urban, recreation

Banksia Street is an artificial 'off-line' wetland, constructed in 2010. Low flows are diverted from the westerly arm of Sullivans Creek concrete channel to pass through the wetland, then overflow back into the westerly channel when water levels are sufficiently high.

Native riparian vegetation at this wetland is healthy, with all three vegetative layers represented, featuring large native Poa tussocks, Acacia and teatree shrubs, and Eucalyptus canopy species. Habitat features such as hollows, standing dead trees or woody debris are largely missing, dropping the reach's overall riparian condition score. Large amounts of Phragmites reeds persist along the edges of this wetland, providing habitat for ducks and water birds. Tall Tasmanian blue gums nearby are a favourite food of local gang-gang cockatoos, who can be spotted feeding amongst the canopy when gum nuts are present.

Large numbers of the feral Eastern gambusia fish were caught during spring surveys, as well as Redfin perch fingerlings, another invasive species that predate heavily on waterbugs.

A red Azolla bloom was reported in October by Waterwatch volunteer Lyn Grigg. Azolla is a common, free-floating fern adapted to slow-moving wetlands and ponds. Its presence is natural, and can indicate excess nutrients in the water, but an over-abundance of Azolla can cause low dissolved oxygen. This is because as the Azolla bloom starts to die off, the bacteria that breaks it down consumes available oxygen in the water.

Volunteer Janelle netting for waterbugs in September at Banksia St Wetland

Burra Creek BUR1

Headwaters to Googong Foreshores NR

2022 CHIP Result B (Good)		
2021 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**46**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Poor	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**4**

Reach Facts

Reach network length: approx. 40km
Dominant land uses: Native bush, grazing, rural, conservation

Burra Creek arises in the north-western edge of the Tinderry Mountains and flows into the Queanbeyan River just upstream of Googong Dam. It flows through rural subdivisions and includes the outlet of the pipeline from the Murrumbidgee to Googong water transfer scheme, before passing through the southern end of Googong Foreshores nature reserve.

With extensive historic grazing and land clearing, Burra Creek's riparian vegetation is largely dominated by exotic woody weeds such as willow and poplar, as well as exotic ground cover species including Phalaris and Bearded oat. Sodic soils (those high in sodium) in the reach increase the risk of erosion, and the potential for water logging and salt outbreaks. Ongoing access to the creek by stock exacerbate erosion issues which increases turbidity and reduces riparian revegetation. Two out of the four sites were given a *poor* riparian rating, due largely to the lack of native vegetation present.

Eleven waterbug Orders were surveyed in Autumn where water pennies, an unusual, flat, round beetle larva not often found in the upper Murrumbidgee, were noted. Unlike most beetle larvae, water pennies possess a pair of gills and can breathe oxygen dissolved in water, and as such prefer cleaner, fast flowing streams and rivers.

In December, a predated Eastern long-necked turtle nest was discovered on Burra Creek, just upstream of BUR095. Eastern long-necked turtles dig their nests in river and wetland banks and are easy pickings for keen-nosed foxes.

Predated turtle nest found near BUR095 in December

David Street Wetland SUW1

Sullivans Creek catchment in O'Connor

2022 CHIP Result B- (Good)		
2021 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**10**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Fair**	**1**

Reach Facts

Reach network length: approx. 0.21Ha
Dominant land uses: Urban, recreation

David Street Wetland is the second 'offline' wetland along the westerly branch of Sullivans Creek. It was constructed in 2001 and takes a portion of any higher flows from the concrete stormwater channel. These pass through the wetland then overflow back into the westerly concrete channel, just before it joins the main northern branch.

A high representation of native canopy species, such as stands of large Eucalypts, groves of Acacia and the occasional Casuarina provide important habitat for many of the region's bird species. A flock of 20 King parrots were noted roosting during water quality sampling in March, and Yellow-tailed black cockatoos were seen feeding on Casuarina nuts in September.

Waterbug diversity was where this reach showed big improvements this year, with nine Orders detected in Spring, compared to only four during the same time in 2021. A small number of mayfly nymphs (Order: *Ephemeroptera*) were detected in Autumn for the first time since 2017 but none were detected in Spring. Spring surveys were hampered, in part, from exotic, deciduous trees dropping large amounts of leaf matter in Autumn, creating a thick, sludgy layer on the surface, unfavourable to pollution-sensitive waterbugs. The feral fish, Eastern gambusia, continue to be a problem.

Improvements in water quality, particularly turbidity and nitrogen, had a positive effect on the overall rating, but varied water quality results still reflect the challenges faced in a dynamic urban catchment.

Waterwatcher Aria sampling at David St Wetland in December

Dickson Wetland DIC1

Sullivans Creek catchment

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**10**
pH	Good	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Fair	
Waterbug	**Poor**	**2**
Riparian condition	**Fair**	**1**

Reach Facts

Reach area: approx. 1Ha
Dominant land uses: Urban

Dickson Wetland was constructed in 2011 and is on the lower western slopes near Mt Majura. A large concrete stormwater channel is fed into the constructed wetland, but during high rainfall events the wetland is bypassed. Water from the wetland flows back into the concrete channel and through to Lyneham Wetland, just upstream of the confluence with Sullivans Creek.

Waterbug surveys in November produced disappointing results, with only seven Orders surveyed, and no Orders that are sensitive to pollution. Two invasive species of snail were noted: The Marbled menace (*Physa acuta*), from Europe, and the New Zealand mud snail (*Potamopyrgus antipodarum*). Both species are highly invasive across the world, and their ascendancy follows a general decline of native species. *Physa acuta* adapt to higher salinity and temperature tolerances and can easily outcompete their native rivals. No native Gastropod species were noted during either the Spring or Autumn surveys.

A large family of Wood Ducks with 15 ducklings were reported in November. Healthy vegetation coverage, particularly an impressive example of planted Carex and native Poa tussock species in riparian areas provides habitat for aquatic bird species.

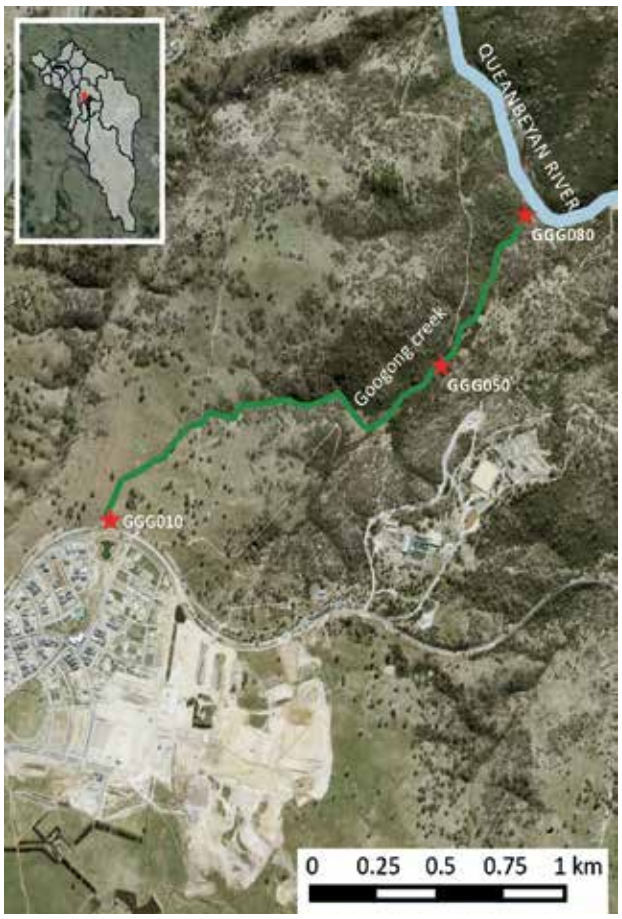
Water quality this year declined with an increase in phosphorus, nitrogen, and electrical conductivity concentrations, despite improvements in dissolved oxygen and turbidity. Increases in nutrients and urban pollutants are typical of urban catchments in periods of increased rainfall and runoff. .

The good diversity of native vegetation is maturing at Dickson Wetland

Googong Creek GGG1

Headwaters to Queanbeyan River confluence

2022 CHIP Result B (Good)		
2021 NO SCORE		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**23**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Poor	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Fair	
Waterbug	**Fair**	**1**
Riparian condition	**Good**	**3**



Reach Facts

Reach network length: approx. 2.5km
Dominant land uses: Native bush, grazing, urban, infrastructure, rural residential

Googong Creek rises in the developing township of Googong and runs into the Queanbeyan River downstream from Googong Dam. It passes through a stormwater holding dam (Beltana Pond GGG010) on the edge of Googong township and crosses a pipeline access track, creating a second dam on the creek. A weir is situated on the downstream section before the creek reaches the Queanbeyan River.

Flowing intermittently, Googong Creek takes discharge from the Googong Water Recycling Plant at site GGG010. Discharge from the plant has been observed to improve turbidity as it dilutes murky water flowing from Beltana Pond, but such events coincide with increases in electrical conductivity and nitrogen levels, plus a notable odour.

Even with healthy riparian vegetation and a high representation of native mid-story riparian species, extreme erosion was found on the dam at GGG050, which has cut the pipeline access track. Higher flows brought on by this year's increased rainfall have proven too much for the small overflow dam, spilling and eroding a deep gully down the dam wall and depositing sand back into the creek, smothering aquatic habitat.

The waterbug survey at this reach produced a high diversity of Orders in Spring. Thirteen Orders were found in total, including some sensitive mayfly Families and three types of caddisfly larvae.

Extreme gully erosion on Googong Creek at GGG050 has cut the access trail

Jerrabomberra Creek JER1

Headwaters to Fernleigh Drive

2022 CHIP Result B (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**23**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Poor	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**3**

Reach Facts

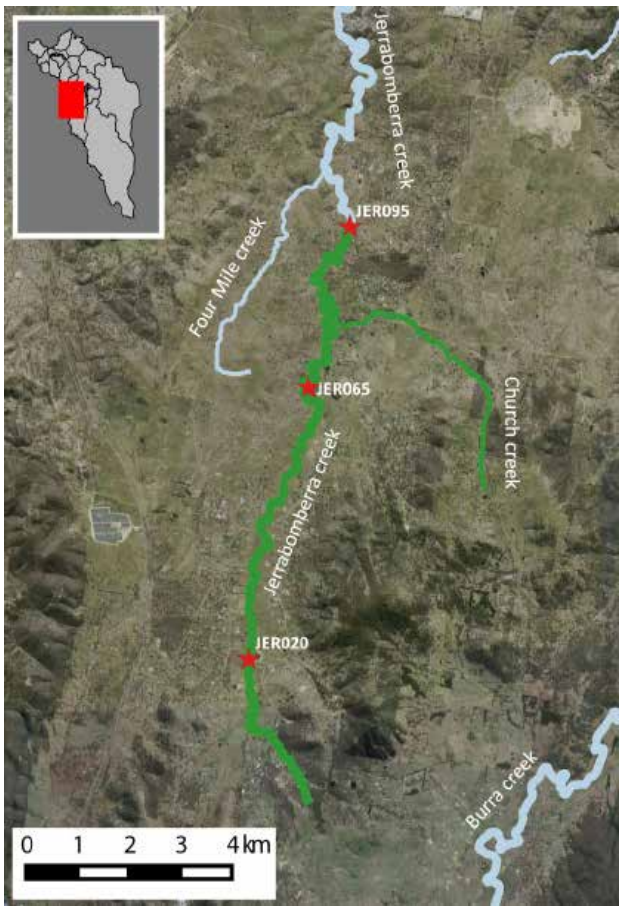
Reach network length: approx. 15km
Dominant land uses: Native bush, Rural residential

Jerrabomberra Creek arises in the hills surrounding the rural residential area of Royalla along the south-east side of the ACT border. This reach, including a number of small tributaries, has varying degrees of riparian condition ranging from healthy sections, rural subdivisions with limited riparian vegetation and sections with deep gully erosion.

Despite bank erosion reported upstream by Waterwatcher Shelly Owen, turbidity and dissolved oxygen saturation saw an improvement this year. Electrical conductivity levels were once again high which is typical of a waterway that has undergone extensive historical land clearing. Landcare riparian plantings upstream of JER095 in 2017, have now matured and are starting to fulfil their ecological function of stabilising banks and allowing native reed beds to re-establish.

Being partially dependant on groundwater for its base flow and in a relatively small catchment, water levels on Jerrabomberra Creek are usually consistent and stable even after heavy downpours. This year's increased rainfall, however, has left the catchment saturated, increasing run-off, and leaving the gentle Jerrabomberra Creek very responsive to rainfall. High or flooding water levels were noted at ten of twelve surveys at JER020.

Large numbers of mayflies were noted during both Autumn and Spring macroinvertebrate surveys. This included some from the genus *Jappa* that possess feathery gills and a pair of horns. They inhabit sandy sections of flowing water and use their horns to burrow in the sandy creek bed.

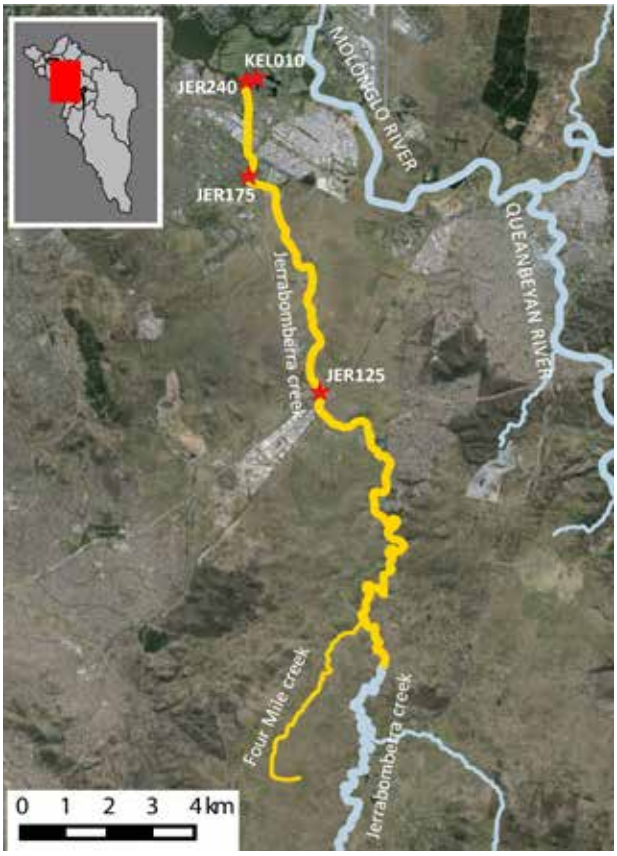


A *Jappa* mayfly nymph with its impressive horns and feathery gills

Jerrabomberra Creek JER2

Fernleigh Park to Molonglo River confluence

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**33**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**4**



Reach Facts

Reach network length: approx. 19km
Dominant land uses: Rural residential, light industrial, urban, conservation, recreation

This reach flows from Fernleigh Park, past residential, rural and industrial areas and a grassland reserve, before ending at the Jerrabomberra Wetlands Nature Reserve (JWNR). The water in the bottom part of this reach is backed up and slowed down by Scrivener Dam, which contains the waters of Lake Burley Griffin. This downstream section of the creek also takes stormwater runoff from major roads and parts of Fyshwick light industrial area.

Mixed land use, from rural, industrial, through to urban, results in *poor* riparian condition ratings. ACT Healthy Waterways plantings at Narrabundah Wetlands, along Jerrabomberra Creek near Canberra Avenue will hopefully improve riparian condition in the future.

Platypus Month results were the worst ever for this site since the surveys began in 2014, with no Platypus spotted at any of the four surveys. The first survey was held directly after a large flow event swept through Jerrabomberra Creek. This may explain their absence for the first week or two as we have had detectability issues post flood at other reaches in the catchment. But there have only been one or two confirmed sightings of Platypus here in the six months since.

Waterbug numbers have seen a notable drop here due to the consistent high flows. Platypus can consume up to a third of their body weight in waterbugs every day so their reliance on this food source may be contributing to their current low numbers.

Volunteer Terry netting waterbugs at the nature reserve (JER240) in March

Lyneham Wetland LYN1

Sullivans Creek catchment off Wattle Street Lyneham

2022 CHIP Result C+ (Fair)

2021 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	**Good**	**12**
pH	Good	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**1**

Reach Facts

Reach area: approx. 1Ha
Dominant land uses: Urban

Lyneham Wetland is a large artificial wetland constructed in 2011–12 fed by stormwater from surrounding suburbs, including Dickson and the large concrete stormwater channel which flows from Dickson Wetland. Unlike Dickson Wetland, however, this is an 'online' wetland which takes all runoff, including high flows following storms. Lyneham Wetland overflows into Sullivans Creek when water levels are sufficiently high.

An improvement in turbidity, decreased electrical conductivity, and increased diversity of waterbugs are responsible for an improved CHIP score. The above average rainfall appears to have flushed sediments and built-up organic matter downstream and provided a more hospitable environment for waterbugs. Deciduous leaves that usually hamper waterbug surveys were far less prevalent during this year's surveys, although fine, suspended plant matter was reported by Waterwatchers throughout the year.

Native edge vegetation also benefited from higher rainfalls this year, which has established nicely and is providing breeding habitat for local aquatic bird species. Ducklings and young coots were reported by Waterwatcher Lyn Grigg. Lyn was also lucky enough to catch a glimpse of an Eastern long-necked turtle digging a nest on the wetland's bank in late November.

Litter continues to be a problem at this reach, as rubbish is washed down storm drains from the city street.

Lyneham Wetland, looking green and lush in December 2022

Molonglo River MOL1

Headwaters to Captains Flat

2022 CHIP Result B (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**6**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**1**

Reach Facts

Reach network length: approx. 3.5km
Dominant land uses: Conservation, grazing, rural residential

From its origins in the north-western section of Tallaganda National Park in the Great Dividing Range, the Molonglo River flows north through grazing properties to Captains Flat. Apart from the presence of wet sclerophyll forest in the uppermost section, this reach is largely cleared rural land with limited riparian vegetation. A lack of mid-story vegetation, as well as missing habitat features such as fallen logs and woody debris, contribute to the *poor* riparian condition score.

A significant improvement on dissolved oxygen saturation has meant *excellent* water quality across all parameters, achieving the best water quality score in the Molonglo catchment.

Waterbug diversity in this reach is high with a range of Families and Genera being detected within the different insect Orders. Two types of stonefly and mayfly nymphs as well as six different Families of caddisfly were noted in high numbers across both waterbug surveys. These three waterbug Orders are considered pollution-sensitive and are a positive indication of water quality and aquatic habitat.

Grader works on Wild Cattle Flat Road in April pushed soil into the Molonglo at MOL030 and left much of the riverbank exposed. A grass fire in September has further reduced riparian coverage, burning Carex and large native tussock grasses growing in the riparian zone. Access to the river by nearby stock may result in a slower recovery of riparian vegetation and risk further erosion issues.

Evidence of a grass fire at MOL030 in September.

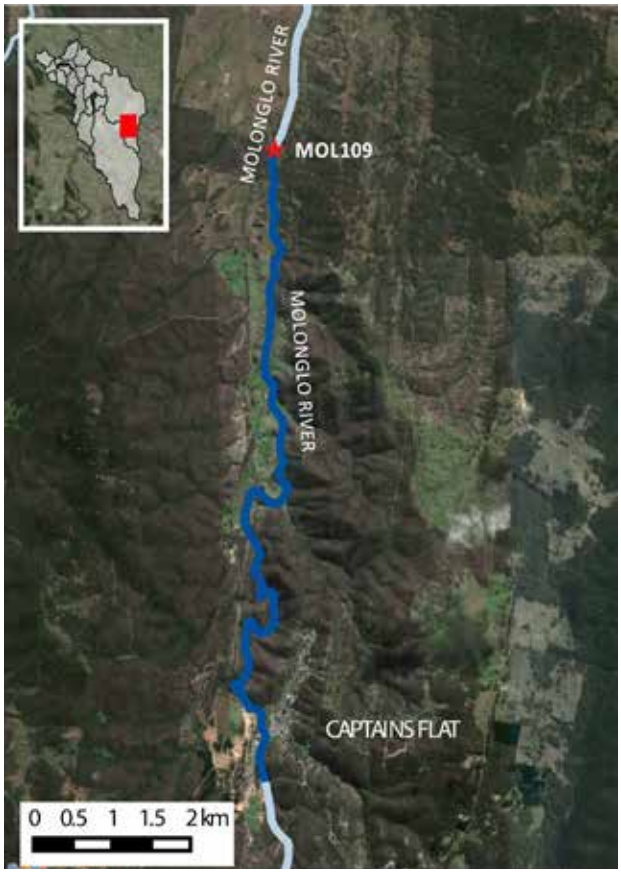
Molonglo River MOL2

Captains Flat to Travelling Stock Reserve

2022 CHIP Result A+ (Excellent)

2021 CHIP Result A (Excellent)

Parameter	Rating	No. Survey
Water quality	**Good**	**11**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Good	
Dissolved Oxygen	Poor	
Waterbug	**Excellent**	**2**
Riparian condition	**Excellent**	**1**



Reach Facts

Reach network length: approx. 10km
Dominant land uses: Grazing, rural residential, mining (historical)

The upstream section of this reach of the Molonglo River begins below the Captains Flat Dam. Leachate from a mine closed in the 1960s continues to contaminate the river with acid minewater and potentially with heavy metals. The Molonglo flows mostly through modified rural land and finishes at the Travelling Stock Reserve (TSR) at 'Foxlow'.

This reach had the only *excellent* riparian condition score in the catchment but, with only one site, this score may not be representative. It does, however, indicate the importance of this TSR in providing essential habitat and refuge for birds and other animals, especially due to its vital connection to Yanununbeyan National Park. In other parts of the reach where land is managed for pastural use, introduced flora such as broom and willow dominate riparian zones. An additional site in this reach would enhance our understanding of the catchment.

Both Autumn and Spring waterbug surveys produced *excellent* results. High numbers were detected over a diverse range of pollution-sensitive waterbugs, including 'headbanger' caddisfly larvae (Family: Leptoceridae, Genus: Notalina) noted in their many hundreds. True to their name, headbanger caddisfly move by thrashing their head violently, projecting them through the water.

Despite an increase in phosphorus and nitrate levels, improvements in dissolved oxygen saturation and increased waterbug diversity, contributed to MOL2's elevation to an A+ grade, highlighting the importance of conserving riparian corridors for improving water quality and biodiversity.

Longtime MOL109 Waterwatchers Steve and Wendy (and Norma the dog) surveying waterbugs in April

Molonglo River MOL3

Downstream of Travelling Stock Reserve near Foxlow

2022 CHIP Result B- (Good)		
2021 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**16**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**3**

Reach Facts

Reach network length: approx. 54km
Dominant land uses: Grazing, rural residential

This reach extends from below the Travelling Stock Reserve south of 'Foxlow' to Burbong Bridge on the Kings Highway and flows through modified rural land and rural subdivisions. The reach includes Plains Creek, Whiskers Creek and Stony Creek, with runoff from the Hoskinstown Plain, which as a frost hollow, is largely treeless.

The Autumn waterbug survey found the three key pollution-sensitive Orders, stoneflies, mayflies and caddisflies. While the first two were only present in small numbers. an impressive seven different types of caddisflies were identified. Eastern gambusia, a small, highly invasive fish from North America, were also caught during the Autumn survey.

Riparian vegetation in this reach is largely exotic: willows dominate the canopy, and hawthorn and Pyrocantha have replaced most of the native mid-storey species. MOL216, located at the Molonglo River Park near Carwoola, has vast infestations of Chilean needle grass and African love grass, which has now taken over the native Poa tussock grasses that once dominated.

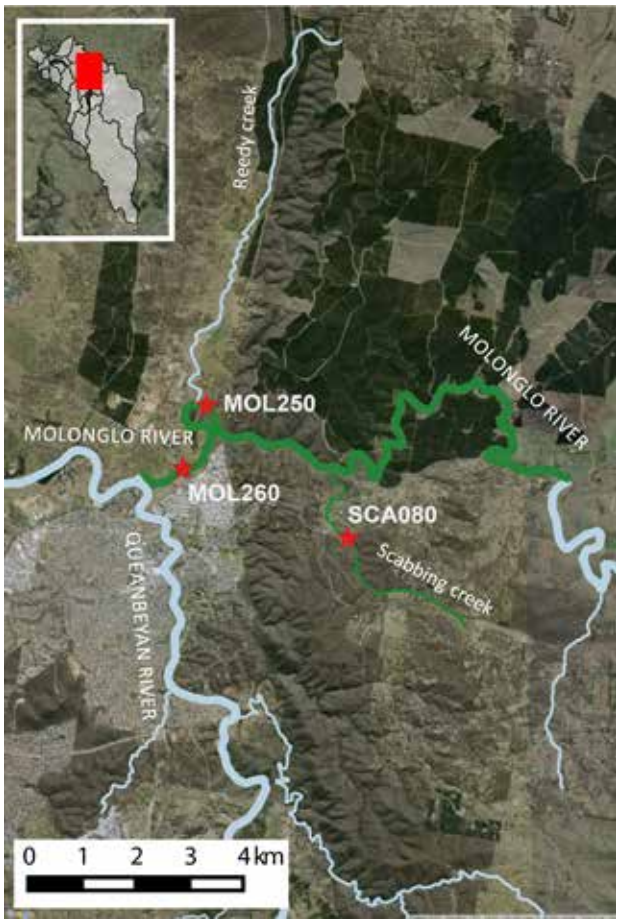
Water quality remained steady this year with *degraded* dissolved oxygen saturation again being the only poor performer amongst generally well received water quality results. Slightly elevated electrical conductivity results are not surprising, as increased run-off from above average rainfall in 2022 possibly leached the sodic soils from the tributary creeks. The concentrations appear to build up slightly as you move downstream.

Debris marks the high flows at MOL210 where Willows are the dominate canopy species

Molonglo River MOL4

Downstream of Burbong Bridge to Queanbeyan River confluence

2022 CHIP Result B+ (Good)		
2021 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**13**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Fair	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**3**



Reach Facts

Reach network length: approx. 16km
Dominant land uses: Grazing, rural residential, forestry, conservation, urban

This reach begins downstream of the Kings Highway at Burbong Bridge on the NSW/ACT border, passes through the southern section of Kowen Forest pine plantation, and through Molonglo Gorge with its faster flows and intact native vegetation, and ends above the confluence with the Queanbeyan River at Oaks Estate. Scabbing Flat Creek, an ephemeral waterway which arises in nearby Cuumbeun Nature reserve, is also included in this reach.

Despite most of the reach flowing through modified forestry and historical agricultural land, the healthy, intact riparian vegetation along the Molonglo Gorge helps to improve water quality. Faster flows over steep rocky sections in the gorge add dissolved oxygen into the water, and in slower sections, riparian vegetation helps to filter and remove nutrients from the waterway.

Waterbug surveys produced surprising results; outperforming reaches further upstream on the Molonglo River. Stoneflies, mayflies and caddisflies, all key pollution-sensitive waterbugs, were present at both surveys with caddisflies particularly in high numbers. Large amounts of filamentous algae were observed in riffle zones in Autumn, but appears to have been flushed away by consistent high flows in Spring. Notably, more stonefly nymphs were found in clean riffle zones during the Spring surveys.

As with other reaches on the Molonglo River, the invasive pest fish, Eastern gambusia, were present in Autumn but not Spring. Higher flows in Spring possibly flushed them downstream.

The Molonglo Gorge near MOL250 has intact, native riparian vegetation

Molonglo River MOL5

Upstream of Lake Burley Griffin

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**19**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Fair	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 10km
Dominant land uses: Urban, industrial, horticulture, grazing

This section of the Molonglo River begins at its confluence with the Queanbeyan River at Oaks Estate, continues on past the Queanbeyan Sewage Treatment Plant near Beard, Fyshwick industrial estate and Pialligo nurseries, close to Canberra airport, then passes an extensive turf growing business. It forms the northern boundary of Jerrabomberra Wetlands Nature Reserve before entering Lake Burley Griffin. Much of the water in this part of the Molonglo River is backed up and slowed down by the presence of Scrivener Dam at the bottom of Lake Burley Griffin.

Flooding throughout the year caused large amounts of rubbish from the township of Queanbeyan to wash down into the Molonglo River, becoming entangled in vegetation on the river's edge.

Large numbers of the pest fish Eastern gambusia were caught during waterbug surveys. These included some large, breeding females that are easily identified by a large black spot on their belly. Waterwatcher and fish enthusiast, Tony Patis, also reported large numbers of Eastern gambusia and European carp at the downstream site at MOL295.

Waterbug diversity and abundance starts to decline on the Molonglo River at MOL5. Pollution-sensitive stoneflies, for example, have never been detected on this reach. This may be because there is a lack of suitable habitat as fluctuating water levels backed up from Lake Burley Griffin restricts potential water bug habitat such as riffle zones and edge vegetation.

Large female Eastern gambusia with distinctive black belly spot, caught at MOL295 in October

Molonglo River MOL6

Scrivener Dam to below Deep Creek confluence

2022 CHIP Result B (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**26**
pH	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Good	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**3**

Reach Facts

Reach network length: approx. 10km

Dominant land uses: Urban, grazing, conservation

This section of the Molonglo River extends from downstream of Lake Burley Griffin to below the Deep Creek confluence, due south of Kama Nature Reserve. This reach encompasses extensive and ongoing Molonglo Valley urban developments and the Molonglo River Reserve runs its entire length.

Ongoing development appears to be changing upstream conditions in this reach and contributing to erosion issues, exacerbated by periods of high rainfall. The small creeks that drain into this section of the Molonglo River such as Yarralumla, Weston and Deep Creek, and the unnamed ephemeral creek downstream of Denman Prospect sediment ponds, all experienced significant bank erosion. Gully erosion upstream of MOL375 continues to be an issue but vegetative cover is returning after three years of construction works at Namarag-Molonglo River Reserve.

A spike in phosphorous was detected in November at MOL350 and nitrogen levels increased over several months, reducing the nitrogen rating for the year. Although the cause is unknown, spikes in nutrient levels are common in urban catchments, particularly during periods of high rainfall, as run-off flushes contaminants from roads, suburbs, sporting fields and construction sites.

Platypus Month surveys are held downstream of MOL350, in August. Promising numbers were surveyed early in the month, with two Platypus and two Rakali spotted during the four surveys, but high flows affected activity and detectability in the latter half of the month.

Erosion on Deep Creek near MOL375 has been worsening in recent years

Molonglo River MOL7

Deep Creek confluence to Murrumbidgee River confluence

2022 CHIP Result B (Good)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**10**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Degraded	
Electrical Conductivity	Poor	
Dissolved Oxygen	Excellent	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**1**

Reach Facts

Reach network length: approx. 16km
Dominant land uses: Urban, infrastructure, grazing, conservation

This reach on the Molonglo River extends from below Deep Creek confluence to the Murrumbidgee River confluence. Prior to 2019 it was the downstream section of MOL6. This reach includes the Molonglo River Reserve and the Lower Molonglo Water Quality Control Centre (LMWQCC) just above the confluence.

This reach is highly influenced by outflows from the LMWQCC, with nitrate spikes of up to 20mg/L being recorded in July. Outflows also contribute to electrical conductivity levels as high as 450µS/cm. Nonetheless, improvement in turbidity and dissolved oxygen, and an increased diversity of waterbugs improved the overall CHIP score for 2022.

The high flows persisted throughout most of the year. Waterwatcher Bridie Noble noted that the footbridge near MOL401 was underwater during six of ten samples.

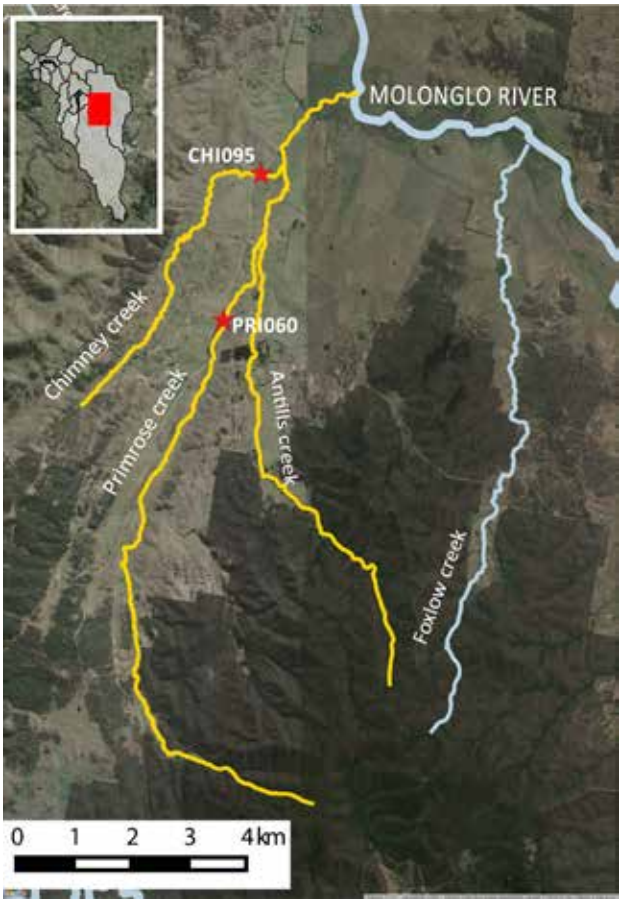
Stonefly nymphs were present at MOL401 in the Spring waterbug survey for the first time since CHIP records began. Stoneflies are amongst the most sensitive Orders of waterbug in the Upper Murrumbidgee catchment and are a significant find so far downstream. Higher flows like those experienced this year flush riffle zone and help to clean rocky river bottoms, creating suitable habitat and favourable conditions for Stoneflies, who prefer clean rocky cobbles and cool, fast flowing water. Other sensitive Orders, such as Mayflies and Caddisflies were surveyed in abundant numbers.

Waterwatcher Bridie identifying waterbugs at MOL401 in April

Primrose Creek PRI1

Headwaters to Molonglo River confluence

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**20**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**2**



Reach Facts

Reach network length: approx. 34km
Dominant land uses: Conservation, grazing, rural

Primrose Creek is a chain of ponds flowing mostly through rural land. Its headwaters are in Yanununbeyan State Conservation Area and Mount Foxlow. It includes Chimney Creek and Antills Creek and flows into the Molonglo River near Carwoola. The lower section of Primrose Creek is actively eroding. With the exception of the headwaters of Primrose Creek and Antills Creek, there is little or no native riparian vegetation, and just a scattering of exotic trees.

A lack of canopy and mid-storey vegetation layers along Chimney Creek gives this reach one of the worst riparian condition scores in the Molonglo catchment. Access to the creek by stock further exacerbates this issue, as native plants struggle to regenerate amongst trampling hooves, hungry sheep, and fast-growing invasive weeds. Bank erosion on the lower sections of Primrose Creek continues to be an issue with poor riparian coverage resulting in unstable riverbanks and soil being washed into the creek during periods of high flow. Young stands of *Acacia dealbata* are maturing in stock-free sections upstream of PRI060, which we hope will help stabilise banks into the future.

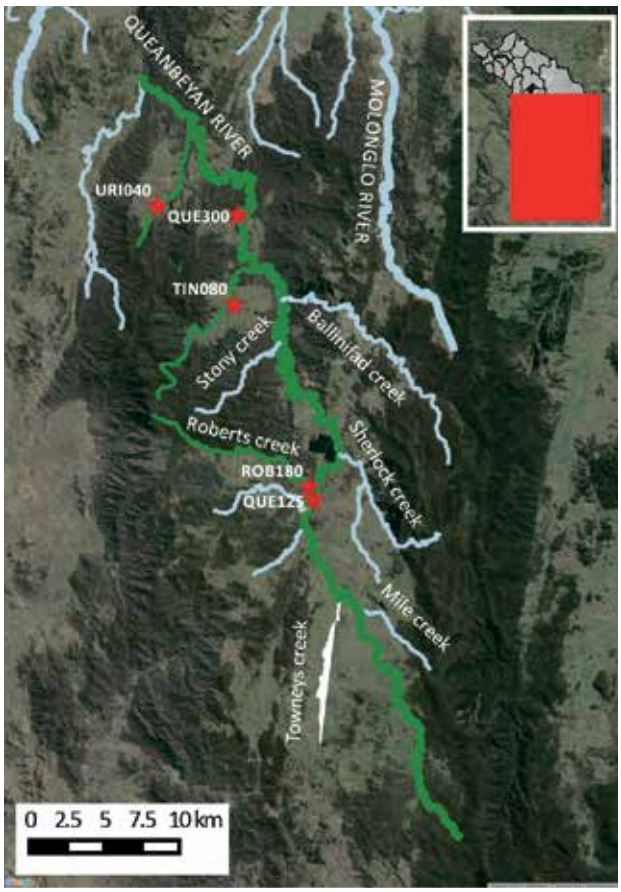
Despite the lack of riparian coverage and active erosion issues, waterbug diversity was high, with 13 Orders detected in the Spring survey. This included the return of pollution-sensitive, stonefly nymphs for the first time since 2020. Scuds (Order: Amphipoda), a small crustacean, were also found in both Autumn and Spring. A rare find in the upper Murrumbidgee catchment, scuds are tolerant of higher electrical conductivity levels.

A lack of canopy and mid-storey vegetation is evident on Chimney Creek (CHI095)

Queanbeyan River QUE1

Upstream of Googong Dam

2022 CHIP Result B (Good)		
2021 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**54**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Poor	
Waterbug	**Fair**	**1**
Riparian condition	**Fair**	**5**



Reach Facts

Reach network length: approx. 143km
Dominant land uses: Conservation, grazing, rural residential

This reach is the largest in the catchment. The upper section of the Queanbeyan River runs from its origins on the southern slopes of the western Tinderry Ranges to Googong Dam in the north. The reach includes Sherlock, Urialla, Tinderry, Lyons, Roberts and Bradleys creeks. The riparian condition on this reach is variable, containing sections of both intact native riparian vegetation and cleared pastural land.

The overall CHIP score dropped due to a reduction in aquatic macroinvertebrate diversity in Spring, with only six Orders surveyed in September. Consistently high flows and multiple flooding events are most likely the cause with waterbugs tolerant to turbulent and fast flowing water present in the surveys, such as stonefly nymphs and blackfly larvae. Waterwatcher Sandy Lloyd reported higher flows or flooding conditions during every water quality survey this year, noting of Tinderry Creek *'Creek flowing strongly - in two months since last test it has flooded and washed away new floodgate with creek debris piled high along banks.'*

Improvements in this year's phosphorous readings give this reach *excellent* water quality ratings across the board with the exception being dissolved oxygen, although it also improved slightly on last year's score. Despite the phosphorus improvement, Waterwatcher Des Cannon noted an incremental increase in phosphorous at Urila Creek (URI040) towards the end of the year after *'years of nil readings'*.

ANU students helping with a waterbug survey on the Queanbeyan River (QUE300)

Queanbeyan River QUE2

Downstream of Googong Dam to city of Queanbeyan

2022 CHIP Result B+ (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**48**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**5**

Reach Facts

Reach network length: approx. 6.7km
Dominant land uses: Urban, rural residential

This section of the Queanbeyan River extends downstream from Googong Dam to the edge of Queanbeyan city. Googong, Montgomery and Gorge creeks near the Googong township, feed into this reach and have their own Waterwatch sites. The Valley Creek flowing out of Cuumbuen Nature Reserve also feeds into this reach. Googong Creek is treated as a separate reach in this year's report (GGG1).

Improvements in water quality were seen 2022, in particular with electrical conductivity. This was most likely due to the removal of the Googong Creek sites from this reach, which regularly see electrical connectivity readings up to four times that of Gorges and Mongomery Creeks. The above average rainfall saw Googong Reservoir overflowing throughout the year which again contributed to improved levels in dissolved oxygen.

The waterbug surveys for this reach reflected a river responding well to three very wet years. Four different Orders that are considered very sensitive to pollution were detected over the two surveys. These included dobsonflies, also known as 'toe-biters'. These ferocious predators live among the cobbles in fast flowing riffle sections of streams and rivers, attaching themselves to the rocks and waiting to ambush any unfortunate prey that washes past. In addition to the 'toe-biters', an impressive eight different types of caddisfly larvae were also noted over the Spring and Autumn surveys.

After ten years, Waterwatcher Sue Gibson handed in her Waterwatch kit at the end of the year. She is a champion for the Queanbeyan River and we wish her all the best.

Dobsonfly larvae, commonly called 'toe-biters', are a top-order, waterbug predator

Queanbeyan River QUE3

Queanbeyan city to Molonglo River confluence

2022 CHIP Result B- (Good)		
2021 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**11**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Fair	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**3**

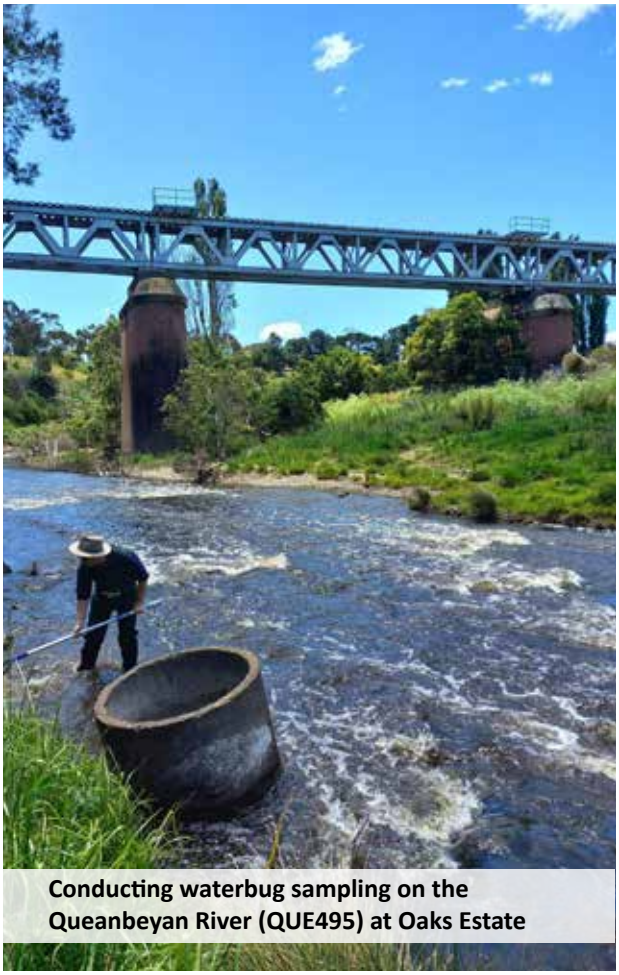
Reach Facts

Reach network length: approx. 9.4km
Dominant land uses: Urban

This section of the Queanbeyan River extends through the city of Queanbeyan to its confluence with the Molonglo River. It takes runoff from Queanbeyan and its suburbs, Cuumbuen Nature Reserve and the eastern slopes of Mt Jerrabomberra. The reach includes Barracks Creek and the Queanbeyan Weir.

Riparian condition scores *poor* with most of the reach running through heavy industrial and dense urban areas. Pockets of Eucalyptus and Casuarina trees are present, although much of the reach is dominated by introduced canopy species, such as willow, Box elder and poplars. As harmful as these weedy species can be, trees in general are important for regulating water temperature and dissolved oxygen by providing shade. Weed removal and plantings done by Molonglo Conservation Group and Queanbeyan Landcare downstream of QUE495 throughout 2022 aim to increase native canopy species along the reach and help end reliance on exotic canopy species as the main provider of shade. As planted native species mature, exotic species can be removed.

Only one lonely stonefly nymph was surveyed at QUE495 this year, but diversity amongst other pollution-sensitive Orders was high. Three different types of mayflies and six types of caddisfly larvae were surveyed in Autumn, as well as large numbers of blackfly larvae. Blackfly larvae produce silk pads which helps them stick onto rocks and logs. They use hooks on their abdomen to hook on to avoid being washed downstream in turbulent conditions.



Conducting waterbug sampling on the Queanbeyan River (QUE495) at Oaks Estate

Sullivans Creek SUL1

Headwaters to Randwick and Flemington Road Pond, Mitchell

2022 CHIP Result C+ (Fair)

2021 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	**Good**	**8**
pH	Good	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 6km
Dominant land uses: Conservation, grazing (historical), industrial

Sullivans Creek originates in Goorooyarroo Nature Reserve, flowing through historical grazing land then into a concrete stormwater channel. It then flows through the new suburb of Kenny, west of Watson, and adjoins the industrial area of Mitchell where it includes the stormwater channel from Exhibition Park (EPIC) and flows through two constructed wetlands. The two Waterwatch sites are located at the inflow and outflow of the most downstream of these wetlands, Flemington Pond.

A combination of erosion on the upper section of Sullivans Creek, inputs from Mitchell industrial area, and large sections of concrete stormwater channel, have resulted in elevated electrical conductivity and phosphorus levels at SUL015. Results at the outlet of Flemington Pond, just downstream at SUL018, shows impressive improvements, highlighting the wetlands function at improving water quality. In October, electrical conductivity was recorded at 890µS/cm at the inlet and 390µS/cm at the outlet, and phosphorous was recorded at 0.07mg/L at the inlet and 0.03mg/L at the outlet. As water flows through the wetland, it slows the creek's flow, letting particles settle, and allowing riparian and wetland plants to filter and remove nutrients from the water.

Flemington Pond, the lower of the two wetlands located on this reach, is a haven for aquatic birds, and supports a surprisingly high diversity of aquatic bird species for an urban wetland. Eight species were noted over the year, including breeding Australasian grebes and a family of Pacific black ducks. Native edge vegetation around the wetland is faring well, providing shelter for such bird species.

Black swans on Flemington Pond, SUL018

Sullivans Creek ANU SUL3

Lyneham Wetland to Lake Burley Griffin confluence

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**21**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**

Reach Facts

Reach network length: approx. 3.7km
Dominant land uses: Urban, recreation

Once known as Ngambri Creek, this section of Sullivans Creek flows into a concrete channel through playing fields and parklands in O'Connor and Turner. It crosses under a number of minor roads and through the Barry Drive gross pollution trap, before entering ANU campus. It passes Toad Hall Pond before continuing through the campus, flowing through some short reed-filled sections and on into Lake Burley Griffin.

Vast improvements in water quality, particularly turbidity, phosphorous and nitrogen, have given SUL3 its highest ever water quality score, bucking the trend of declining water quality in urban areas during periods of higher rainfall. Water quality improvements were also noted in upstream wetlands located on Sullivans Creek.

Electrical conductivity remained high, typical of catchments with large sections of concrete stormwater channels. *Degraded* dissolved oxygen levels, particularly in February and March, coincide with Cyanobacteria (Blue-green algae) blooms in Lake Burley Griffin and back up into the lower Sullivans Creek site at SUL765.

Rubbish and pollution continue to be a problem on the reach, as litter flows downstream from Canberra CBD, and debris washes into Sullivans Creek from water backed up by Lake Burley Griffin. Waterwatcher Michael Burton remarked in December at SUL745 *'A lot of plastic rubbish at the drain inlet to the stream'* and at SUL765 in March, *'Water very dirty with hydrocarbon traces and floating debris.'*

Dusky Moorhen's nest at Toad Hall Pond (SUL375).

Watson Wetlands and Ponds WAT1

Justice Robert Hope Park to Aspinall Street

2022 CHIP Result C- (Fair)

2021 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	**Good**	**10**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Degraded**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 1.4km
Dominant land uses: Conservation, urban

Watson Wetlands and ponds are on the lower western slopes of Mt Majura nature reserve, across the road but contiguous with the nature reserve. They comprise a drainage line, with two dams, in remnant yellow box/red gum grassy woodland at Justice Robert Hope Park, which overflow during high rainfall. 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.

Phragmites and Cumbungi, both tall, fast growing, native reeds, have quickly taken over at WAT040, restricting access and choking the outlet where water sampling is conducted. Blackberry is starting to take foot on the northern edge of the wetland and will quickly spread if not controlled soon.

Waterbug numbers declined this year with only seven Orders surveyed across both spring and autumn. Caddisflies, considered to be pollution-sensitive, were a notable omission from this year's surveys. A decline in dissolved oxygen since 2019 may be responsible for their absence. Unlike pollution-tolerant Orders, caddisfly larvae lack the ability to breath atmospheric oxygen, leaving them vulnerable to low dissolved oxygen saturation in our waterways.

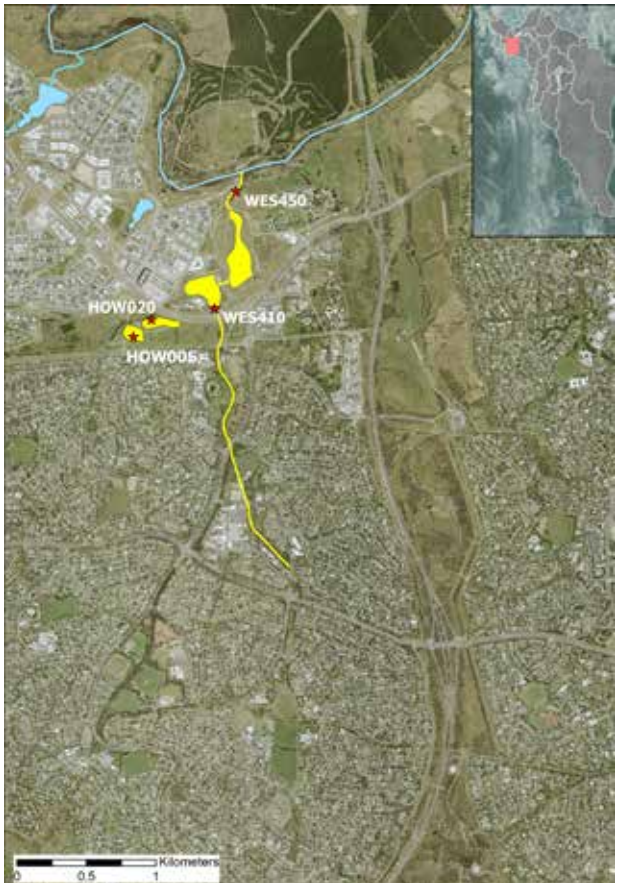
WAT010, the wetland on Roma Mitchell Drive was singing with frogs in October, with three species identified amongst the chorus during water sampling. Large numbers of Common eastern froglet make this wetland home, and although small and well camouflaged, can make quite the racket.

A quick water sampling demonstration for some curious locals at WAT040 in September.

Weston Creek WES1

Headwaters to Molonglo River confluence

2022 CHIP Result C (Fair)		
2021 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Fair**	**37**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Poor	
Nitrate	Poor	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**4**



Reach Facts

Reach network length: approx. 6.7km
Dominant land uses: Urban.

This reach includes drainage from the western side of Mt Taylor, and Stirling Ridge. It flows in a concrete stormwater channel through the Canberra suburban area of Weston Creek before entering ponds on the south-east edge of the new Molonglo Valley suburban area. It then passes close to the eastern side of Coombs, where development is nearing completion, and on to the confluence with the Molonglo River.

The rock installed to armour the bank against erosion on the lower section of Weston Creek has been breached. High flows flooding the channel and spilling around the rocks have caused considerable erosion on the eastern bank and deposited large amounts of sediment into the Molonglo River. Large established reed beds upstream of WES450, (below the outlet of the North Eastern Pond) help to buffer higher flows but not enough for this year's above average rainfall. Flows can increase considerably during periods of high rainfall in catchments consisting of lots of impermeable surfaces such as roofs, roads and concrete stormwater channels.

Such impermeable surfaces most likely contributed to the *poor* and *degraded* results for a number of the water quality parameters. Urban run-off can wash nutrients, salts, minerals and heavy metals into waterways which lack the in-stream complexity that can serve to draw these out and contribute oxygen back into the water. Samples taken at both the inlet and outlet of Holder ponds show its proficiency at improving water quality. Phosphorous levels were better at the outlet every month samples were taken, and nitrogen was better six out of eight months.

Erosion on Weston Creek near WES450 in October

Woolshed Creek WOO1

Headwaters to Molonglo River confluence

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**20**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network length: approx. 19km
Dominant land uses: Rural, urban, site of Majura Parkway

Woolshed Creek originates at a farm dam situated over a spring. It flows through highly modified rural land with some native riparian vegetation in the upper sections and some significant waterholes. Two short sections of the creek were moved to make way for Majura Parkway. The creek joins the Molonglo River near Fairbairn Avenue, just upstream of Lake Burley Griffin. Lower Woolshed Creek has an important fossil site with rare Silurian Period fossil beds.

Given its hydrogeology and extensive historical land clearing, the Majura Valley has salt outbreaks in the landscape which can strongly affect electrical conductivity in the creek. Waterwatcher Terry Moore recorded a huge range in electrical conductivity readings at WOO050, near where the groundwater feeds into the creek proper. 220µS/cm was measured in September when surface flows from upstream had a diluting effect, through to 1230µS/cm in February when groundwater influences dominated.

Despite *degraded* electrical conductivity readings, waterbug diversity was high, finding 13 Orders, as well an as impressive diversity amongst Orders. Stoneflies, sensitive to higher salinity levels, have still never been detected in Woolshed Creek.

Large flows noted by Terry in October caused some havoc, flattening the flood depth marker under Majura Road and helping disperse blackberry brambles that are starting to take hold in the downstream section at WOO090.

Evidence of high flows at WOO090 on Woolshed Creek in November

Yandyguinula Creek YAN1

Headwaters to Molonglo River confluence

2022 CHIP Result B+ (Good)		
2021 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**8**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Fair	
Waterbug	**Good**	**2**
Riparian condition	**Good**	**2**

Reach Facts

Reach network length: approx. 18km
Dominant land uses: Conservation, grazing, wetlands

Yandyguinula Creek is an ephemeral tributary of the Molonglo River, with the confluence at 'Foxlow' near Hoskinstown. It arises in Tallaganda National Park on the western side of the Great Dividing Range and flows into modified rural land with little or no riparian vegetation other than willows. Near its confluence with the Molonglo River, it passes through an extensive wetland area which supports a significant bird population.

High quality native vegetation cover as well as large amounts of in-stream debris and structure on the reach's upstream section, boost the riparian scores and provide habitat for waterbugs. Moving downstream riparian cover varies. As state forest and national park give way to cleared grazing land, riparian vegetation alternates between thick stands of willow and blackberry and patches of native edge vegetation.

Waterbug diversity at this reach is high, with four types of mayfly being recorded in April, and two Families of stonefly noted in Spring. Unfortunately, Redfin perch were also caught this year. An invasive species, Redfin are known to predate waterbugs, and can have exponential population growth. Redfin also spread the viral disease Epizootic Haematopoietic Necrosis (known as the EHN virus), a significant threat to native fish species.

We say goodbye to veteran Waterwatcher, John Bissett, who has been sampling Yandyguinula since 2014. John's commitment to Waterwatch over the years has been outstanding, sampling seven sites and completing over 519 samples. Thanks John!

Healthy riparian coverage on Yandyguinula Creek

Yarralumla Creek YAR1

Headwaters to Molonglo River confluence

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**43**
pH	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**5**

Reach Facts

Reach network length: approx. 10km
Dominant land uses: Conservation, urban

Yarralumla Creek includes three drainage lines which run largely in concrete channels, one along the west side of Mt Mugga Mugga, one from Farrer to Phillip, and one from Long Gully to Garran. The reach also includes East O'Malley Pond. Yarralumla Creek then runs parallel with Curtin in a concrete stormwater channel and down to the Molonglo River, immediately below Scrivener Dam. 2021 saw the addition of sites from Mawson Ponds which has been recently constructed to treat stormwater overflow from the creek as it runs through Mawson.

Large sections of this reach contain stormwater drains. This, combined with the fact that the edge vegetation on the newly built Mawson Ponds is still establishing, has meant this reach has only received a *poor* riparian condition score. Native edge vegetation planted around O'Malley Ponds has lifted the overall riparian condition score up from *degraded* levels in 2021, but a recent incursion of blackberry along the riverbank near Hindmarsh Drive is threatening the establishment of native plantings.

An impressive 13 waterbug Orders were surveyed at YAR400 in spring, including large numbers of pollution-sensitive types like mayflies and caddisflies. This is a surprising result for a catchment with significant urban stormwater inputs. Infrastructure upgrades, completed under the ACT Healthy Waterway Program in 2017, have helped increase in-stream vegetation which has provided more habitat for waterbugs.

Eastern water dragons are a common sight at YAR400 on Yarralumla Creek

Southern ACT Catchment Facts

For the purposes of this report, the Southern ACT area is divided into ten main sub-catchments; the Murrumbidgee River, Naas River, Gudgenby River, Cotter River, Paddy's River, Orroral River, Lake Tuggeranong, Point Hut Pond, Stranger Pond and Guises Creek. This is Ngunnawal Country.

The headwaters of the Cotter, Naas, Gudgenby and Orroral River systems are at some of the highest elevations in the ACT, originating in the mountains of the Namadgi National Park. The Cotter River provides our main drinking supply and flows north, next to the Brindabella Ranges. Paddy's River is a smaller rural waterway flowing to the west of the Bullen Range, past forestry land and grazing properties to the immediate west of Canberra. Its catchment includes the Tidbinbilla Nature Reserve and Gibraltar Creek.

The Lake Tuggeranong, Point Hut and Stranger Pond systems are urban waterways in the southern half of Canberra with inputs flowing in from the east. The Lake Tuggeranong inflows are extensively engineered with pipes and concrete channels. The Point Hut Ponds were designed more recently and feature upstream wetlands and terraced, vegetated stormwater channels

Guises Creek is a small base flow creek on the eastern edge of the ACT adjacent to the Monaro Highway.

All of these waterways join the Murrumbidgee River in the ACT, which flows north from Angle Crossing, near Tharwa. For the purposes of this report, Southern ACT catchment finishes at Uriarra Crossing, just before the Molonglo River confluence in the north west corner of the ACT.

The Upper Murrumbidgee Demonstration Reach (UMDR) partnership works to protect and improve the health of all Murrumbidgee River. From 2019 it has expanded its region to include all of the Murrumbidgee mainstem in the southern ACT.

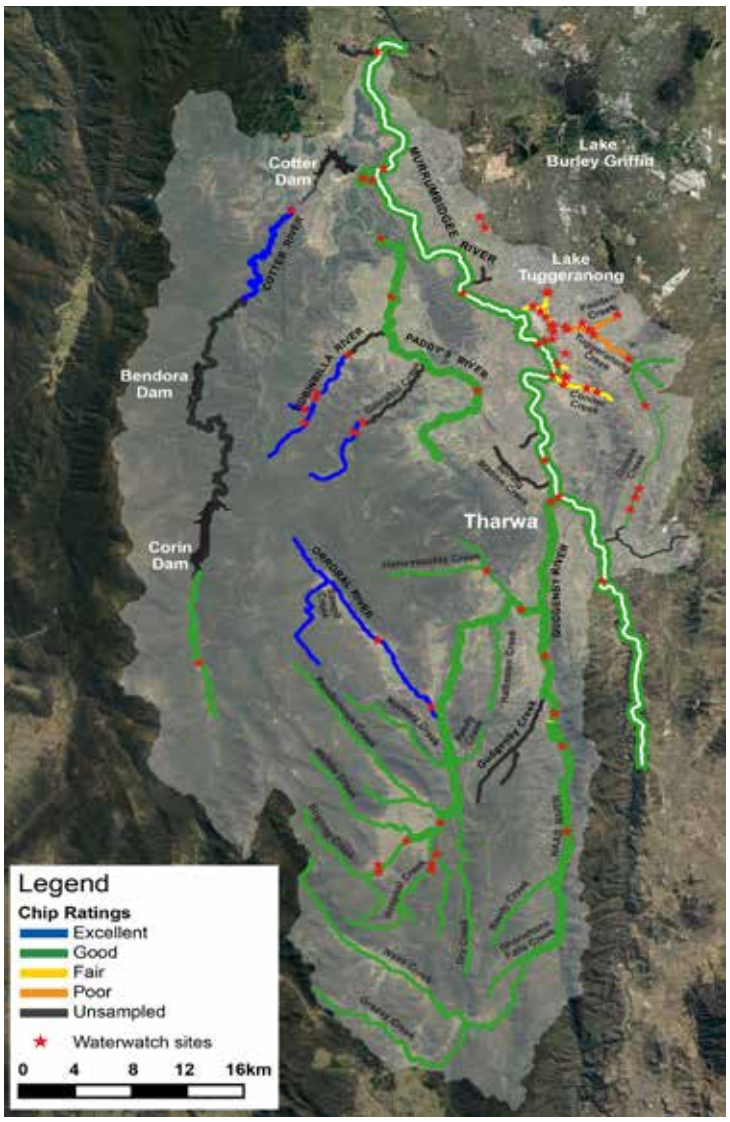
Southern ACT Catchment Health Summary

Southern ACT Waterwatch volunteers continued to monitor in challenging conditions with record breaking rainfall. This year saw 19 out of our 27 reaches achieve *good* or *excellent* scores - the best this catchment has seen in history of the CHIP report. Fifteen reaches improved, eight were the same and only four reaches scored lower than in 2021. Of the reaches with better grades, fourteen saw waterbugs as a key driver and seven showing improved water quality.

The improved waterbugs scores were driven mainly by greater diversity. This was witnessed around the catchment, but in particular in the Paddy's River catchment (including Tidbinbilla), the Orroral River and the Murrumbidgee River reaches (CMM7-CMM10). Lake Tuggeranong also showed a significant increase in waterbug Orders. The reaches that saw declines mostly did so because of low waterbug diversity. This included the upland reaches of the Naas River (NAA1), Tuggeranong Creek (TUG1) and Hospital Creek (HOS1) that were subject to high energy flows which can flush the bugs away.

High flows resulted in varied water quality too. Dissolved oxygen levels increased in many urban and rural waterways with over half of the reaches in the southern ACT showing improvements. While phosphorus concentrations decreased across the catchment, cyanobacterial blooms (blue green algae) were still observed in Lake Tuggeranong and Point Hut Pond. Nitrates were still detected at high levels in the Lake Tuggeranong catchment, and are an ongoing issue in such highly urbanised areas. Turbidity continued to be a problem for the Paddy's River and urban lakes as unstable catchments see sediment mobilised after heavy rain.

Riparian condition continues to be a key catchment health issue in the Southern ACT. The majority of the reaches scored *fair* or worse with only five rated as *good* or *excellent.* The latter are all in parts of upper catchment that escaped severe fire damage in 2020, such as the Orroral campsite and Gibraltar Creek. In recent years there have been revegetation and weed removal projects in the Murrumbidgee, Gudgenby and Naas River catchments. This work needs to continue to see long term benefits to these precious rivers.



Barney's Gully MMB1

Woodcock Drive, Gordon to confluence with Murrumbidgee River

2022 CHIP Result B- (Good)		
2021 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**4**
pH	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**1**
Riparian condition	**Fair**	**1**

Reach Facts

Reach network length: approx. 1km
Dominant land uses: Peri urban, conservation and recreation

Barney's Gully is an ephemeral creek near Woodcock Drive, Gordon. This natural creek flows into the Murrumbidgee just over a kilometre downstream of Point Hut Crossing. It is one of the last original clay bed creeks that form a chain of ponds full of bull-rushes and only flows after periods of rain. Most other similar creeks in the Tuggeranong valley have been converted to concrete stormwater channels and/or dammed to form urban lakes.

This small creek is showing the positive effects of years of hard work by the Parkcarers of Southern Murrumbidgee (POSM). Leaky weirs and erosion control works have promoted abundant reeds and ground cover with lush, green growth reported in the channel as well as the riparian zone throughout the year. There is an abundance of wildlife now regularly seen and four species of frogs have been recorded.

Despite all the terrific restoration works conducted here, water quality can still be problematic. Unusually low dissolved oxygen (33mg/L) and high phosphorous (0.05mgL) were recorded in January, with water having a 'milky appearance'. Poor electrical conductivity levels are common too, due, in part, from the salts and mineral leaching from clay soil.

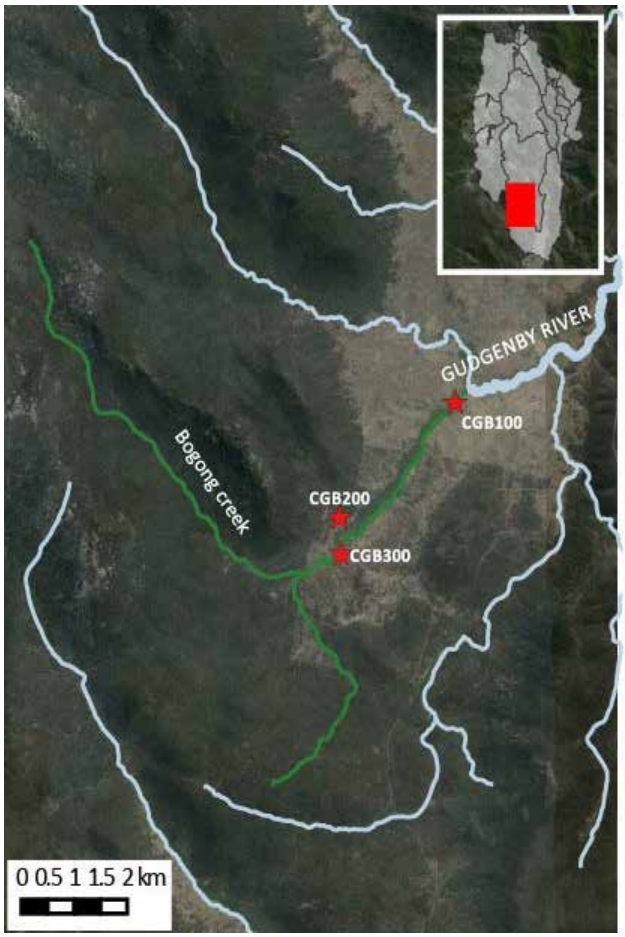
Waterwatcher Deb Kellock, part of the POSM team, monitored here for 12 years and retired in March. We thank Deb for her dedication to this little waterway and to many others.

Thanks to Waterwatcher Deb for all her efforts at Barney's Gully

Bogong Creek Catchment BOG1

Headwaters to Yankee Hat trail bridge

2022 CHIP Result B+ (Good)		
2021 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**28**
pH	Good	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Good	
Waterbug	**Excellent**	**2**
Riparian condition	**Fair**	**1**



Reach Facts

Reach network length: approx 13km
Dominant land uses: Conservation

This reach is in the Namadgi National Park and is part of the Gudgenby River catchment. At its downstream end Bogong Creek is a wide and mostly treeless upland creek/bog.

The *fair* riparian score shows the ongoing effects of the 2020 bushfires. A riparian assessment conducted in March found canopy regeneration and growth of large native tussock grasses. Leaf litter and woody debris are lacking but understory species are starting to reappear. As Waterwatcher Michaela from the Gudgenby Bush Regenerators noted, *'[the] creek has changed a lot since the fires but the plants have grown back very well.'*

The waterbug surveys also showed promising signs for the fire-affected areas of the catchment. The middle site (CGB200), that was directly burnt by the fires, hosted a *good* diversity of pollution-sensitive waterbugs in November including 'streamhorse' mayfly nymphs (Family: Coloburiscidae) most commonly found in cool, upland streams. The downstream sites (CGB100) also had *excellent* waterbug diversity and abundance in Autumn. The wet year saw significant improvements in dissolved oxygen levels along the whole creek system, improving from *poor* to *good*. This no doubt supported the healthy waterbug results.

A '*black feral dog*' was sighted by the Waterwatchers in September at the most upstream site (CGB300) and feral pig damage was noted at CGB100 several times in the second half of the year.

Flooding was evident at CGB300 in November 2022 (photo: J.Lehane)

Cooleman Ridge Dams RAN1

Two dams on Cooleman Ridge

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**22**
pH	Fair	
Turbidity	Fair	
Phosphorus	Fair	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

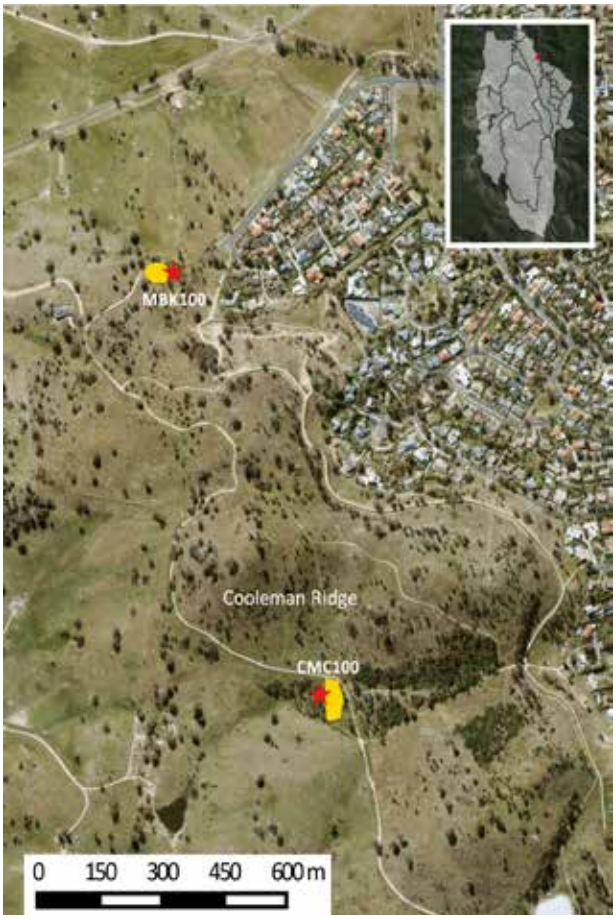
Reach network area: approx. Kathner Street Dam 0.05Ha, Old Dam 0.15Ha
Dominant land uses: Suburban reserve

Kathner Street Dam (MBK100) is a small dam in Cooleman Ridge Nature Park. It was made to provide water for horses as part of the bicentennial trail. The 'Old dam'(CMC100) is on the eastern slopes of Cooleman Ridge and has a stock exclusion fence with off-dam watering for cattle installed since 2019. There was significant planting around the old dam by the Cooleman Ridge Parkcare group last April. This is yet to be captured through the riparian assessments which are conducted every two years.

Both dams remained full all year and the wet weather flushed out the dams considerably, lowering phosphorus concentrations and improving pH results. The increased runoff from the surrounding landscape also washed the clay soils into the dam, increasing turbidity levels.

There was a good diversity of waterbugs. There were three mayfly Families and many 'stick' and 'flat shack' caddisfly larvae (Family: Leptoceridae). All of these waterbugs are sensitive to pollution. A high number of very tolerant types lowered the overall score including small 'needle bugs' that are often seen here. Most of the waterbugs in the dams obtain their oxygen from the air which helps them get around the low dissolved oxygen issues here.

Cooleman Ridge Parkcarer, Pat Ryan, handed the Waterwatch kit to other members in May after monitoring here since 2008. Thanks Pat!



Plantings to improve riparian habitat at Cooleman Ridge old dam, August 2022 (photo: P.Lindenmayer)

Cotter River COT1

Headwaters to Corin Dam

2022 CHIP Result B (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**3**
pH	Fair	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Poor	
Waterbug	**Fair**	**1**
Riparian condition	**Fair**	**1**

Reach Facts

Reach network length: approx. 12km
Dominant land uses: Drinking water catchment and conservation

This reach covers the top of the Cotter River above Corin Dam in the Bimberi Wilderness area. Much of this reach's catchment is dominated by a low Eucalyptus canopy. Access to the public is restricted as, along with COT2, it forms part of the ACT's main drinking water supply. Monitoring began in September 2020 and is conducted by ACT Parks and Conservation staff. Feral deer are a significant issue.

A survey of riparian condition early this year found abundant regrowth of native Eucalypt canopy and associated shrub species as the catchment continues to recover from the 2020 bushfires. While this is a promising sign, it will take some years for this to be reflected in the riparian condition scores.

Monitoring was limited to February thorugh to April as the site was inaccessible for the remainder of the year. At that time, Ranger Mark found the water had a dissolved oxygen saturation of around 80% and a pH of 6. Cotter River water is known by Icon Water to have low alkalinity and associated low pH.

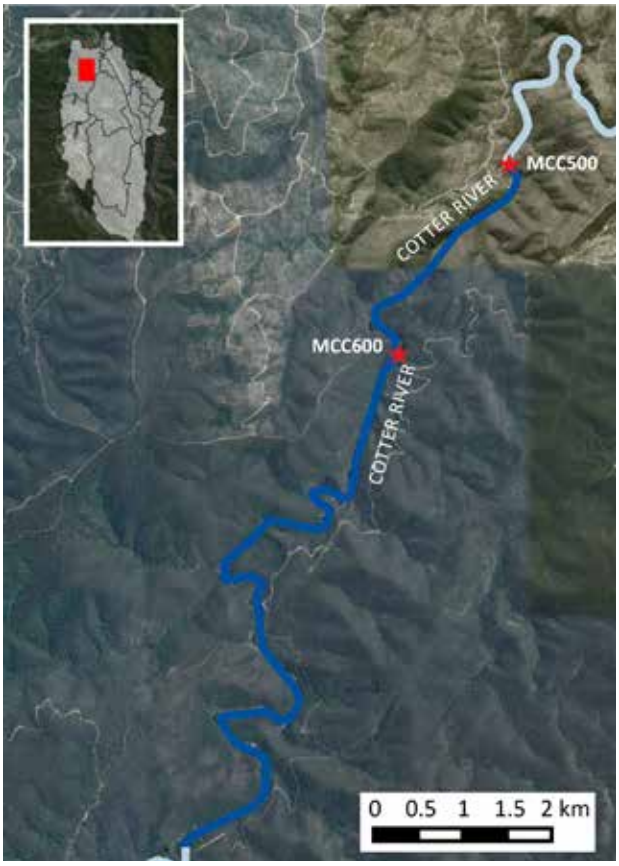
Only six different Orders of waterbug types were found during the Autumn survey. High flows in the preceding weeks were most likely the cause. Ideally you wait until flows go down and bugs re-establish before conducting the surveys but this rarely happened during a very wet 2022. While this lack of diversity at the Order level drives down the waterbug score, there were an impressive variety of pollution-sensitive types within those Orders. Hundreds of stonefly, caddisfly and mayfly from, collectively, nine different Families, were detected.

'Stream horse' mayfly nymphs, detected in the Autumn waterbug survey, prefer cool, upland streams

Cotter River COT2

Pipeline Road Crossing to Vanity's Crossing

2022 CHIP Result A (Excellent)		
2021 CHIP Result A- (Excellent)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**20**
pH	Fair	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	**Excellent**	**2**
Riparian condition	**Good**	**2**



Reach Facts

Reach network length: approx. 11km
Dominant land uses: Drinking water catchment and conservation

This reach runs along the stretch of the Cotter River between the Bendora and Cotter dams. Large bimonthly releases of water from Bendora dam combined with the ongoing environment flow releases help maintain this reach's condition.

This section of the Cotter has restricted access for vehicles and is heavily monitored and managed by Icon Water and the ACT government. This is in part due to the area being a significant part of the ACT's water utility as well as having a remnant population of the endangered Macquarie Perch. Waterwatch monitoring is exclusively conducted by ACT Parks and Conservation rangers.

The electrical conductivity readings are some of the lowest in the entire upper Murrumbidgee catchment, ranging between 30-40µS/cm all year. Like in the Cotter reach above Corin Dam, the pH is slightly lower with regular readings of 6 and 6.5.

This year the Autumn waterbug survey was conducted at Spur Hole with the help of Ranger Sally. Most of the insects caught were very small but included all the key pollution-sensitive Orders including several dobsonfly larvae, commonly known as 'toe biters' (Order: Megaloptera). An exciting find was a 'vulture' caddisfly larvae (Order: Atriplectididae). As the name suggests they devour other insect corpses. Six of the ten Orders found were sensitive to pollution.

The Cotter River above Cotter Dam, October 2022

Cotter River COT3

Cotter Dam to Murrumbidgee River confluence

2022 CHIP Result B (Good)		
2021 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**20**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	**Fair**	**2**
Riparian condition	**Fair**	**2**

Reach Facts

Reach network length: approx. 2.5km
Dominant land uses: Recreation

This reach covers the relatively short stretch of the Cotter River below the Enlarged Cotter dam. It includes the confluence with the Paddy's River at the 'Cotter Bend' carpark and terminates at the confluence with the Murrumbidgee River. Inflows from the Paddy's River can significantly affect the water quality flowing past the Cotter Campground.

The riparian vegetation only ever achieves a *fair* assessment as the reach is managed for public amenity. Although there is a healthy population of Casuarinas, old large deciduous trees from historic park planning are abundant and there is little debris and understory that contribute to a healthy riverbank.

Overflows from the Cotter Dam delivered twelve months of clean, clear water to the lower Cotter River giving it one the best water quality scores for the upper Murrumbidgee catchment this year.

While nine different Orders of waterbug were found in the April survey, overall numbers were low. There was some improvement in October with good diversity but the dominant bug in the sample was pollution-tolerant blackfly larvae. These results were possibly due to the relentless high flows experienced in this reach over much of 2022 that meant many bugs were unable to establish between flushing events.

Jill and Maree observed in December at the Cotter campground (SCR300) that there were '*adventitious roots visible around the base of the Casuarina*'. This is a fibrous root system, often red in colour, that can appear above the ground on Casuarinas if they are stressed from excess flooding.

The Cotter River at the campground (SCR100) showing evidence of high flows (photo: M.Blume)

Gibraltar Creek GIB1

Headwaters to Woods Reserve

2022 CHIP Result A (Excellent)		
2021 CHIP Result A (Excellent)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**24**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Fair	
Waterbug	**Good**	**2**
Riparian condition	**Excellent**	**2**

Reach Facts

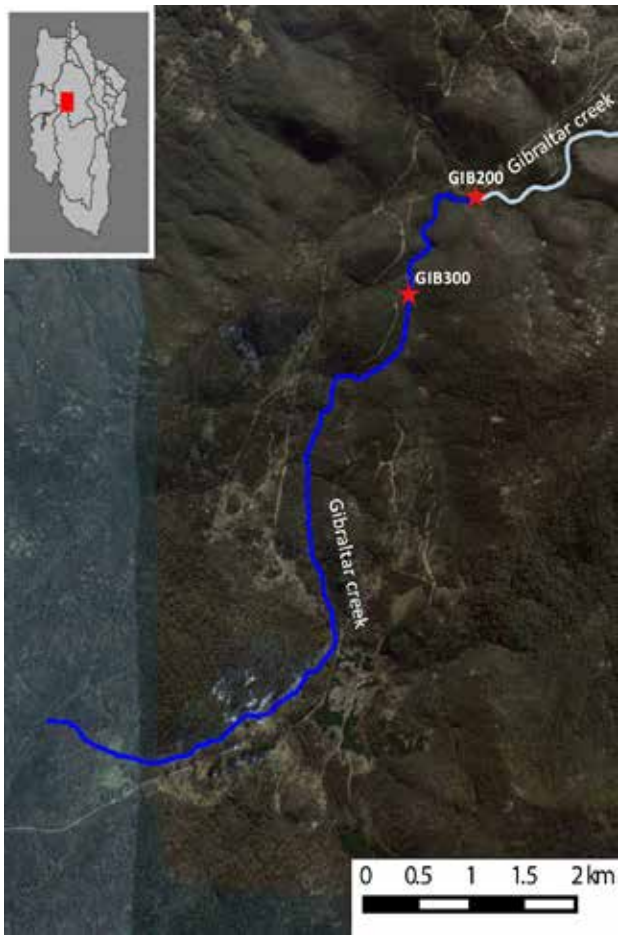
Reach network length: approx. 8.5km
Dominant land uses: Recreation and forestry.

Gibraltar Creek is a small stream originating near Corin Dam and flowing east through Corin Forest to Paddy's River. The upper section is part of an upland bog system. Most of the surrounding land was used for softwood plantations up until the 2003 bushfires. The catchment also has a high recreational use with a large campsite, public access waterfall and a popular commercial facility.

This reach regularly receives one of the highest CHIP scores due, in part, to it having outstanding riparian condition. Although burned again in 2020, a survey the following year showed the vegetation was still *excellent* with a complex structure of native vegetation.

Gibraltar Creek lost its perfect water quality score this year as dissolved oxygen levels were a little lower at times than in 2021.

While only six different Orders of waterbug types were found in Autumn, this included a great variety of pollution-sensitive types within those Orders. Gibraltar Creek can be hard to sample for waterbugs as all the rocks are quite large and hard to maneuver around to flush the bugs into the net. While the riparian vegetation is very healthy, there is limited edge vegetation which can also affect diversity. In Spring, the sampling focused on some small debris pools and side riffles and eight Orders were detected. This included many sensitive types including a large predatory stonefly nymphs (Family Eusthenidae) more often seen in alpine and sub-alpine streams.

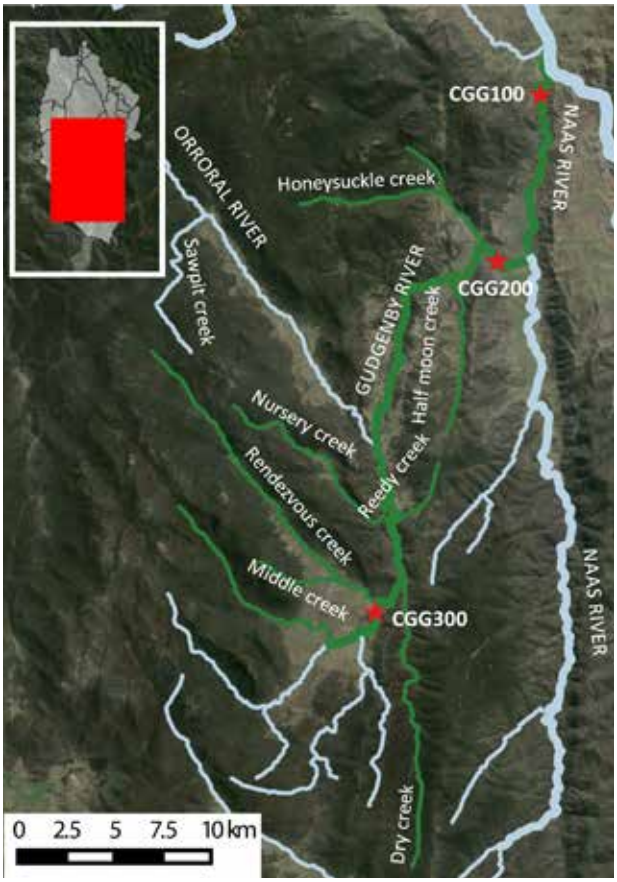


This 30mm Eustenid stonefly, found in Gibralter Creek, requires clean, fast-flowing streams

Gudgenby River Catchment CGG1

Headwaters to the Murrumbidgee River confluence

2022 CHIP Result B+ (Good)		
2021 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**33**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Excellent	
Waterbug	**Excellent**	**2**
Riparian condition	**Poor**	**3**



Reach Facts

Reach network length: approx 35km
Dominant land uses: Conservation and rural grazing

This reach includes the full length of the Gudgenby River from the headwaters in Namadgi National Park to the confluence with the Murrumbidgee River near Tharwa. Seven kilometres flow through the northern end of the park while the remainder runs mostly through mixed grazing properties.

The riparian vegetation in the rural stretch lacks significant native tree cover and understory. The riparian vegetation in the national park is still very much affected by the 2020 fires. A riparian assessment at the most upstream site (CGB300) in November found some regrowth of native canopy and midstorey shrubs, increasing leaf litter and, as expected, lots of fallen, dead logs.

The wet year gave the river a good flush, reducing the electrical conductivity concentrations (salts and minerals) and improving dissolved oxygen levels. In April Waterwatcher Sam noted at CGG200 'Highest level I've seen and very fast flowing.' The lower sites showcase the effects of an unstable catchment with ash and sand smothering the substrate. Waterwatcher Deb Kellock noted at the Smith's Road Bridge (CGG100) 'site is different every month with bank & vegetation changes from high flows & frequent floods.'

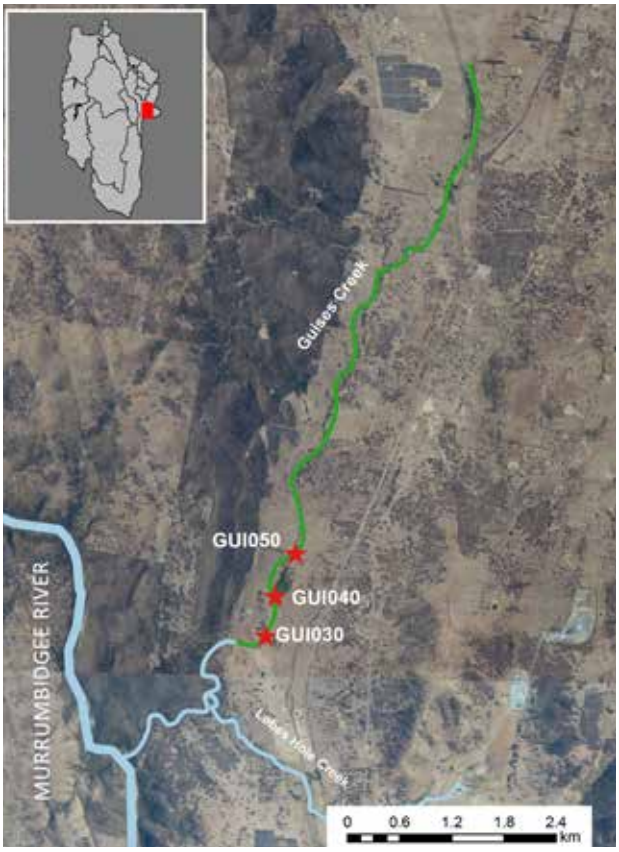
Waterbug surveys at site CCG200 in April and CGG300 in November saw the return of *excellent* results with healthy numbers of pollution-sensitive species and an overall doubling in the diversity of waterbug Orders compared to 2021. That said, charcoal was still being picked up in November during the waterbug sampling.

The impact of the bushfires is still evident in the upper sections of the Gudgenby River (photo: J.Lehane)

Guises Creek Catchment GUI1

Headwaters to confluence with Murrumbidgee River

2022 CHIP Result B- (Good)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**11**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Poor	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**3**



Reach Facts

Reach network length: approx 6.4km
Dominant land uses: Rural grazing

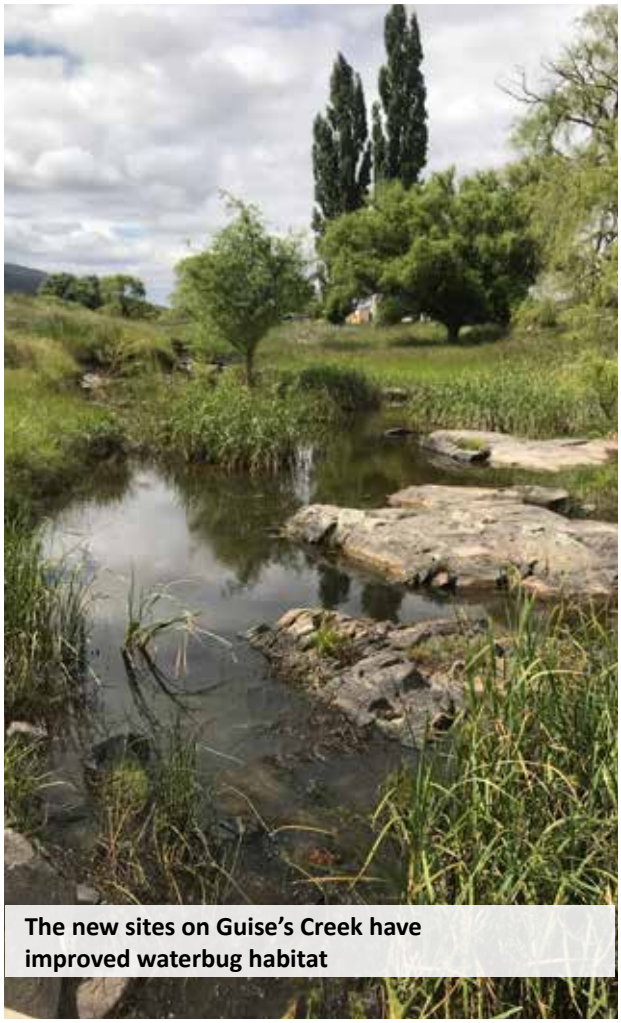
Guises Creek is a permanent spring sitting on ignimbrite bedrock adjacent to the Monaro Highway on the eastern border of the ACT. The reach extends from its head at Royalla to a large dam on Guises Flat Homestead then on to the boundary with Gigerline Nature Reserve.

The creek passes through rural grazing properties and the riparian vegetation is mostly comprised of weed species and exotics trees. Establishing native revegetation on this creek would significantly improve the riparian condition score and the overall catchment health.

The monitoring at Rosevue Homestead has ceased and new sites were established downstream at Guises Flat Homestead. Landowner Sarah regularly hosts land restoration activities through Landcare and Greening Australia on her property and is interested to monitor the effects of this on waterway health.

The moving of the sites most likely had a part to play in the slight improvement of the water quality score. Electrical conductivity concentrations were on average half that of upstream at Rosevue with the highest being 780µS/cm in 2021 compared to 360µS/cm in 2022. Dissolved oxygen levels were also slightly higher possibly as a result of the higher flows or the increased presence of in-stream plants at some of the downstream sites.

Waterbugs results also showed an improvement on last year. Surveys conducted on Sarah's property showed a great diversity with three key pollution-sensitive types; stoneflies, mayflies and caddisflies being detected in both Autumn and Spring.

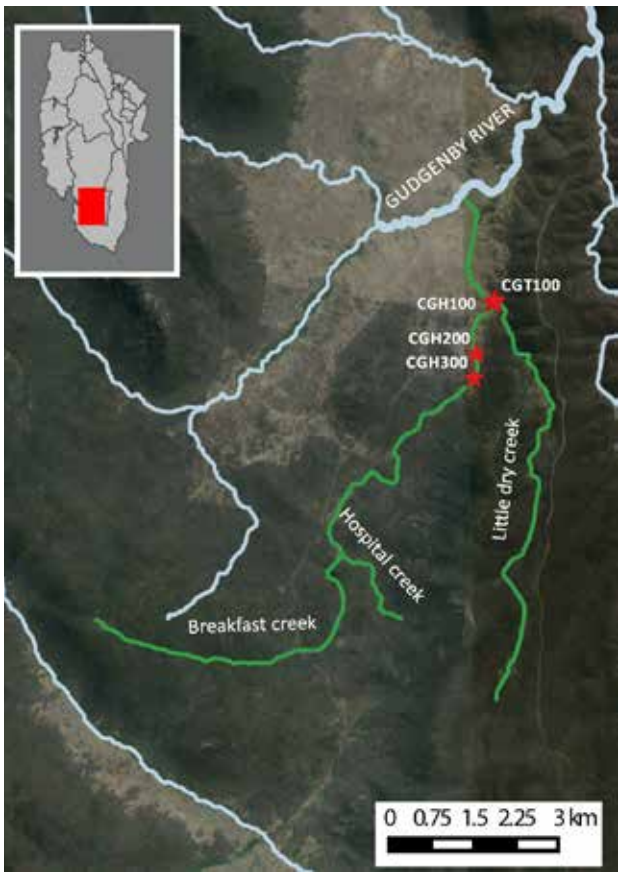


The new sites on Guise's Creek have improved waterbug habitat

Hospital Creek Catchment HOS1

Headwaters to the confluence with the Gudgenby River

2022 CHIP Result B+ (Good)		
2021 CHIP Result A- (Excellent)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**44**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Good	
Waterbug	**Excellent**	**2**
Riparian condition	**Fair**	**1**



Reach Facts

Reach network length: Hospital Creek arm; 12km, Little Dry Creek arm; 7km
Dominant land uses: Conservation

Hospital Creek is mostly a forested gully situated south east of Bogong Creek, in Namadgi National Park. It runs north, forming as upland bog before joining the Gudgenby River near its headwaters. Little Dry Creek is an ephemeral arm to the east of Hospital Creek.

Hospital Creek was a significant area for cattle grazing from the mid 1800's to early 1900's. The area also hosted pine forest production until the 2003 bushfires.

A riparian condition survey of Little Dry Creek in March found debris and leaf litter still missing as a result of the 2020 fires although good canopy regrowth was noted. There were also many weeds such as thistle and St Johns wort.

The continued presence of nutrients, measured as phosphorus and nitrates, helped feed streamers of green algae at the confluence of Little Dry Creek and Hospital Creek. Pig damage and scats were observed on a number of occasions throughout the year, which may also be contributing to the nutrient levels.

Waterwatcher Hannah, a keen entomologist with the Brindabella Venturers, spotted an unusual insect at CGH100 in November which was later confirmed to be a nationally endangered Key's matchstick grasshopper *Keyacris scurra*. It had not been recorded from Hospital Creek before. One of the many side benefits of Waterwatching!

The Key's matchstick grasshopper was an exciting find for Waterwatchers at Hospital Creek (photo: H.Zurcher)

Isabella Pond ISA1

Large pond south of Monash

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**17**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Degraded	
Electrical Conductivity	Poor	
Dissolved Oxygen	Fair	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**3**

Reach Facts

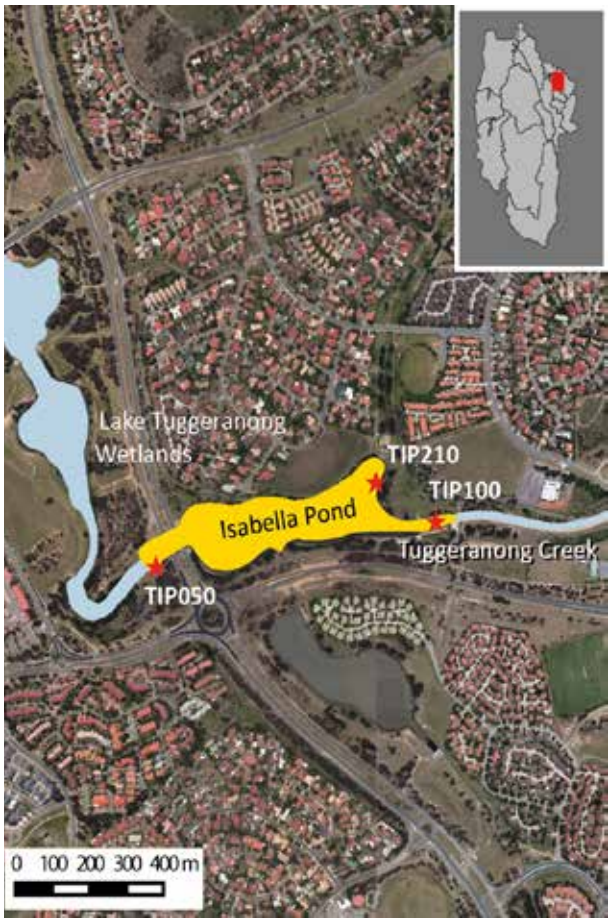
Reach network area: approx. 5.8Ha
Dominant land uses: Suburban

This reach is the main settlement pond for stormwater entering Lake Tuggeranong from the south western Tuggeranong suburbs. Water flows over a high weir at its western end into Lake Tuggeranong (TLT1).

Isabella Pond underwent an extensive facelift from 2018 to 2019 with several hectares of wetland vegetation plantings. The aim is to trap nutrients that would otherwise be carried into the main lake which then contribute to toxic blue-green algal blooms.

The high inflows in 2022 carried lots of runoff from the surrounding, urbanised catchment. The southern site recorded a nitrate reading in March of 7.5mg/L and it rarely dropped below 3mg/L. Both of these readings fall within the *degraded* range. Electrical conductivity ranged from 100-690µS/cm and can be an indicator of stormwater pollution. A visible oil slick seen at TIP210 in May further highlights the effects of pollution washed in through the stormwater system.

Water bug surveys involved sifting through samples with tangled mats of filamentous algae. In Autumn, overall numbers were very low and the sample was dominated by 'blood worms', a type of fly larvae that persists in low oxygen environments. Other waterbugs found in large numbers from the Order Hemiptera that can breath air. In Spring, two pollution-sensitive waterbug types were detected in low numbers but they were vastly outnumbered by hundreds of snails, that can thrive in water containing high nutrients and organic matter.



Isabella Pond has an array of riparian and in-stream plants to help absorb nutrients such as nitrates

Lake Tuggeranong Wetlands TLT1

Drakeford Drive weir to South Quay foot-bridge weir

2022 CHIP Result C (Fair)

2021 CHIP Result C+ (Fair)

Parameter	Rating	No. Survey
Water quality	**Fair**	**24**
pH	Good	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Degraded	
Electrical Conductivity	Poor	
Dissolved Oxygen	Fair	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**2**

Reach Facts

Reach network area: approx. 4.3Ha
Dominant land uses: Urban

This is the southern section of Lake Tuggeranong, upstream of the weir that runs under a pedestrian walkway near the South Quay Development. It forms a narrow neck at the southern end below a large zigzag dam wall trapping the waters from Isabella Pond directly upstream. This is the main input to this reach in addition to a number of other smaller stormwater drains. Part of the function of Lake Tuggeranong Wetlands is to treat the stormwater before it enters Lake Tuggeranong proper.

There is a healthy stand of Casuarinas on either bank at the very end of the Lake but very little in the way of other native plants. Site TLT300 sits next to a large area of concrete paving.

Elevated nutrient concentrations continues to be a problem in many parts of the Tuggeranong catchment and this reach was no exception. While phosphorus levels improved slightly on 2021, concentrations of 0.05mg/L were regularly detected during wet weather. Nitrates were also commonly detected at *degraded* levels of 3mg/L. Electrical conductivity levels increased slightly this year and *degraded* levels of dissolved oxygen were detected by Waterwatch Jen at TLT300 during the warmer, Summer months.

In May, while conducting the waterbug survey, light-blue, soapy water was noted flowing from a drain off Anketell Street. A search of the nearby building works, with the help of the site manager, found no obvious source. The Environment Protection Agency was duly notified.

On a more positive note, Eastern long-necked turtles and water dragons are a common sight in this reach.

Blue runoff at a gross pollutant trap was flowing into Lake Tuggeranong wetlands in May

Lake Tuggeranong TLT2
Main lake body

2022 CHIP Result C+ (Fair)

2021 CHIP Result D+ (Poor)

Parameter	Rating	No. Survey
Water quality	**Good**	**49**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Good	
Nitrate	Poor	
Electrical Conductivity	Fair	
Dissolved Oxygen	Poor	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**5**

Reach Facts

Reach network area: approx. 56Ha
Dominant land uses: Urban and recreation

This is the main body of Lake Tuggeranong, which is fed by the stormwater systems of thirteen south Canberra suburbs. Two major gross pollution traps are at the northern end of this reach. Lake Tuggeranong wetlands, to the south, (TLT1) are immediately upstream of this reach.

Nitrate levels decreased and dissolved oxygen levels rose slightly this year as high stormwater flows entered the Lake. This brought soil and organic matter which increased turbidity and phosphorus concentrations, providing food for Blue-green algae (Cyanobacteria). Kate, while monitoring as part of her International Baccalaureate, noted large amounts of white foam coming from the Village Creek pipes in Winter. This can happen when surfactants (detergent-like compounds) in leaf litter are agitated by high flows.

This year there was a significant improvement in the waterbug score from *degraded* in 2021 to *fair*. This was driven by good diversity in addition to two pollution sensitive species being found at the Town Park Beach. Two mayfly nymphs from different families and a good number of caddisfly larvae. Water mites were the only sensitive bug to be found at MTW100. The bulk were fly larvae, worms and springtails.

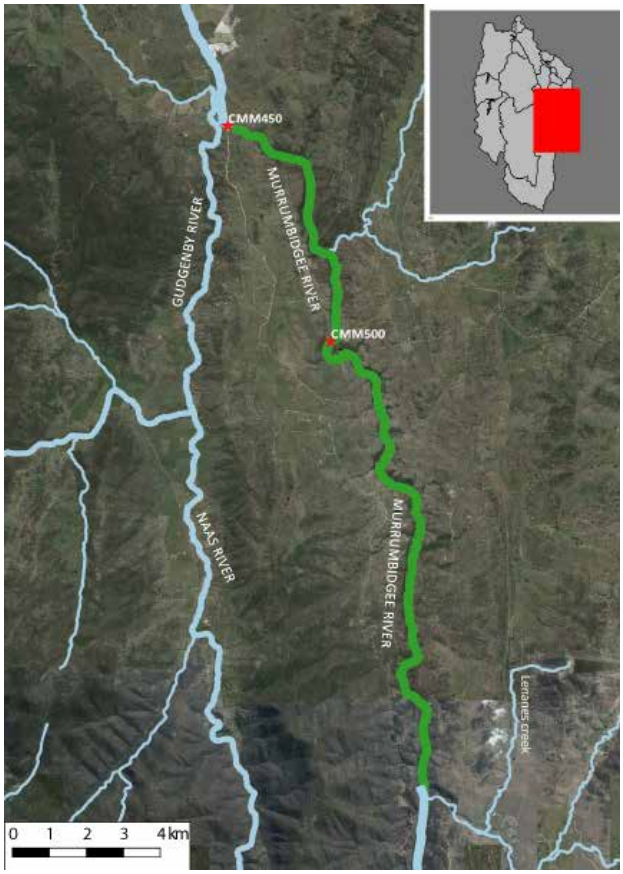
The improvement in riparian condition score this year has captured some increase in native ground cover and debris under the trees near the town park beach. At MTW100 there is an increase in Kangaroo grass *Themeda triandra*, and Casuarinas increasing in size and emerging as regrowth.

Waterwatcher Kate showing off the new water testing uniform (Photo: E.Bell).

Murrumbidgee River CMM7

Michelago Creek confluence to Tharwa Sandwash

2022 CHIP Result B+ (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**21**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Fair	
Waterbug	**Excellent**	**1**
Riparian condition	**Fair**	**2**



Reach Facts

Reach network length: approx. 24km
Dominant land uses: Rural grazing and conservation

This stretch of the Murrumbidgee River begins at Willows Road NSW, includes Angle Crossing on the ACT/NSW border and runs through the Gigerline Gorge in the ACT. It ends in the area known as the Tharwa Sandwash in the Gigerline Nature Reserve.

Recreational fishing is banned in the ACT section of this reach and riparian vegetation is significantly healthier than downstream around the Tharwa township. Around Angle Crossing, however, there is a distinct absence of trees as well as limited amounts of emergent and edge vegetation and a lack of native ground cover at Tharwa Sandwash. There are also very few reeds or other macrophytes, which are important habitat for fish and waterbugs.

While the water quality scored *excellent* again this year, there were slight decreases in dissolved oxygen and increases in electrical conductivity. While turbidity also scored *excellent*, levels as high as 50 and 60 NTU were recorded at both Waterwatch sites during flood events throughout the year. Thankfully, these readings were the exception, and the mostly clear river was a far cry from the 400NTU readings it was getting just after the 2020 bushfires.

Waterbug surveys conducted at Angles Crossing normally produce good results. This year was no exception with ten Orders detected in the high flowing riffle in early December. Along with five Families of caddisfly larvae, 'stream horse' mayfly nymphs (Family Coloburiscidae) were found. These are normally only seen in cool, upland waterways and is a good reflection on the current health of the Murrumbidgee.

The Murrumbidgee River in flood at Tharwa Sandwash in October

Murrumbidgee River CMM8

Tharwa Sandwash to Point Hut Crossing

2022 CHIP Result B (Good)		
2021 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**24**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Poor	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**2**

Reach Facts

Reach network length: approx. 10km
Dominant land uses: Rural grazing and conservation

This reach covers the stretch of Murrumbidgee River from Tharwa Sandwash to Point Hut Crossing. Most of the eastern bank of this reach borders Lanyon Homestead. The western bank flows past a number of properties including Castle Hill and Lambrigg Homesteads in the Tharwa district.

The riparian vegetation in this reach is extremely poor with very few mature canopy species. The shallow gradient of this section of river also compounds the problem of sediment build up which reduces the chances for in-stream habitat, such as riffles, to establish. The shallow depths combined with a lack of shading, means the average water temperature at Tharwa is often warmer than at upstream or downstream sites. These areas of the river make passage difficult for aquatic fauna such as native fish and Platypus.

A series of Engineered Log Jams constructed over the past decade are aimed at deepening the adjacent channels in this reach with juvenile Murray cod and Murray River crayfish having been observed.

While high flows made netting for waterbugs difficult at times, a great diversity of waterbug types were found at Point Hut Crossing this year. Twelve different Orders were detected in December including five different types of pollution-sensitive caddisfly. A 15cm freshwater prawn (*Macrobrachium sp* - so called because of their large front legs) was also found. These crustaceans feed on algae and plants and are an important component of the diet of many freshwater fish such as the aforementioned Murray cod.

The Murrumbidgee River at Point Hut Crossing, April 2022 (photo: J.Koehler)

Murrumbidgee River CMM9

Point Hut Crossing to Kambah Pool

2022 CHIP Result B (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**12**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Waterbug	**Fair**	**2**
Riparian condition	**Fair**	**2**

Reach Facts

Reach network length: approx. 7km
Dominant land uses: Urban, conservation and recreation

This reach covers the section of Murrumbidgee River from Point Hut Crossing to Kambah Pool, which includes Pine Island reserve and Red Rocks Gorge. Urban inputs from Tuggeranong Creek, Stranger Pond and Point Hut Ponds are also received into this section of the Murrumbidgee River.

This reach had faster flows, deeper water and slightly more abundant bank vegetation, such as stands of native Casuarina trees, than the mostly shallow, treeless sections near Tharwa. That said, the riparian condition assessment still indicates that this section lacks significant native understorey and groundcover species.

Water quality improved overall as the elevated nitrate levels detected in 2021 have returned to within the *good* to *excellent* range, while dissolved oxygen levels also improved.

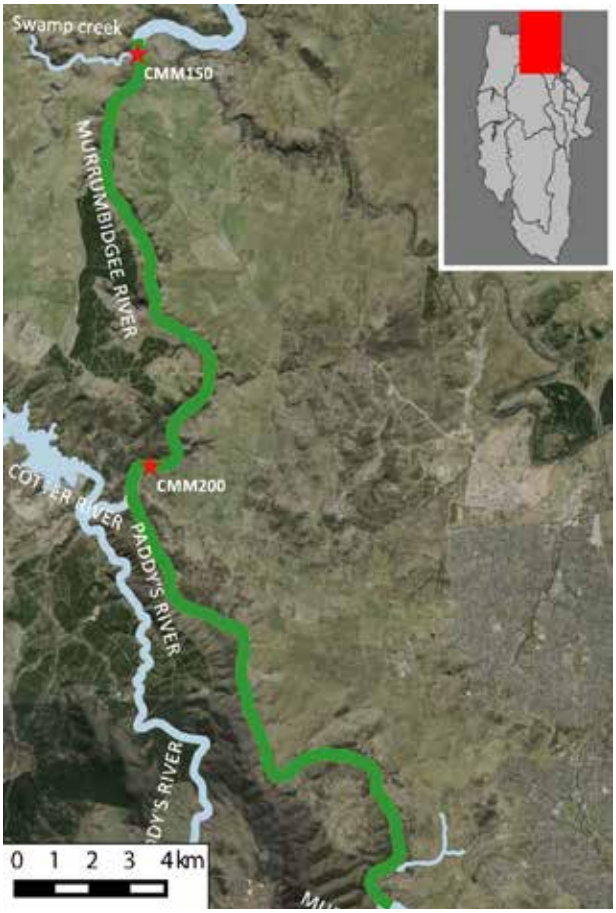
Waterbug surveys were varied over Autumn and Spring in this reach. Diversity was low in May with only seven Orders and overall low abundance; receiving a *degraded* result. The constant high flows throughout Autumn may have been playing a part here as bugs may not have had time to re-establish before the next high flow came and flushed them away. By late Spring however, the riffle was scoured clean and accessible for sampling. Nine Orders were detected with plenty of diversity among the pollution-sensitive waterbugs such as stoneflies, mayflies and caddisflies. A lack of edge vegetation at the sampling site, may have contributed to keeping overall diversity down.

The Murrumbidgee River at Kambah Pools (CMM250), May 2022

Murrumbidgee River CMM10

Kambah Pool to Uriarra Crossing

2022 CHIP Result B (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**24**
pH	Excellent	
Turbidity	Good	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Fair	
Waterbug	**Good**	**3**
Riparian condition	**Poor**	**2**



Reach Facts

Reach network length: approx. 11km
Dominant land uses: Rural grazing, forestry, recreation and conservation

This reach covers the section of Murrumbidgee River from Kambah Pool to Uriarra Crossing. Much of it flows past old pine forest plantations and areas still used for grazing and farming. This section of the river receives inputs from both the Paddy's and Cotter Rivers entering just upstream of Casuarina Sands Reserve (CMM200).

Turbidity is higher in this reach than in CMM9 and is likely due to sediment coming from the rural Paddy's River catchment that has issues with erosion. Conversely, phosphorus levels were lower possibly due to some dilution of the Murrumbidgee water by the Paddys and the Cotter rivers. Dissolved oxygen levels were down again this year which is in line with levels found upstream in the Murrumbidgee and Paddy's rivers.

The distribution of mature native trees and shrubs in this reach is sparse. Ground cover, while extensive, mostly consists of weed species such as African lovegrass, Curly dock and Blackberry. Combined with the absence of hollow bearing trees and leaf litter, that both provide essential habitat, the result is a *poor* riparian condition score for this reach.

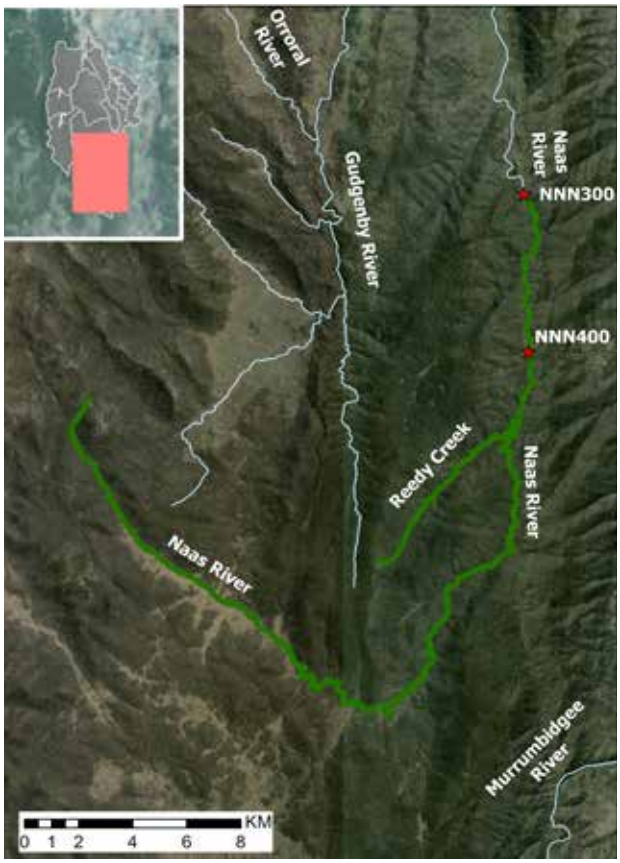
In May at Uriarra Crossing (CMM150) there were a good number of pollution-sensitive waterbugs although they were outnumbered by thousands of tough, pollution-tolerant waterboatmen (Order: Hemiptera, ie. 'true bugs'). Hundreds of stonefly nymphs, one of the most sensitive waterbugs, were detected in the clean, riffle habitat in Spring.

The Murrumbidgee at Uriarra Crossing (CMM150)

Naas River NAA1

Headwaters to boundary of Namadgi National Park

2022 CHIP Result B+ (Good)		
2021 CHIP Result A- (Excellent)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**12**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Excellent	
Waterbug	**Fair**	**2**
Riparian condition	**Good**	**1**



Reach Facts

Reach network length: approx. 34km
Dominant land uses: Conservation

This stretch of the Naas River runs next to the eastern boarder of the ACT in Namadgi National Park. Shanahan's Falls Creek joins Naas Creek near Horse Gully Hut in a steep gully to form the river proper which is then fed by numerous small creeks as it flows north through rocky dry sclerophyll forest between the Booth and Clear View Ranges.

Limited access due to rain-damaged trails has meant that a riparian assessment of the upstream site (NNN400) has not occurred since October 2019. Anecdotal reports from PCS rangers say the upper catchment was severely burnt and has issues with erosion and weed infestations. The riparian condition assessment of the downstream site showed native trees and shrubs having little damage from the fires. There are, however many herbaceous weeds including large thistles and purpletop *Verbena bonariensis* along the river bank.

The steep, narrow and rocky nature of the upper Naas River means flows are very responsive to rainfall, particularly when the catchment is already saturated. The wet year had a positive effect in flushing out nutrients and associated ash and sediment from the fires. Phosphorus levels went from *poor* levels of 0.06mg/L in 2021 to barely detectable *excellent* results in 2022.

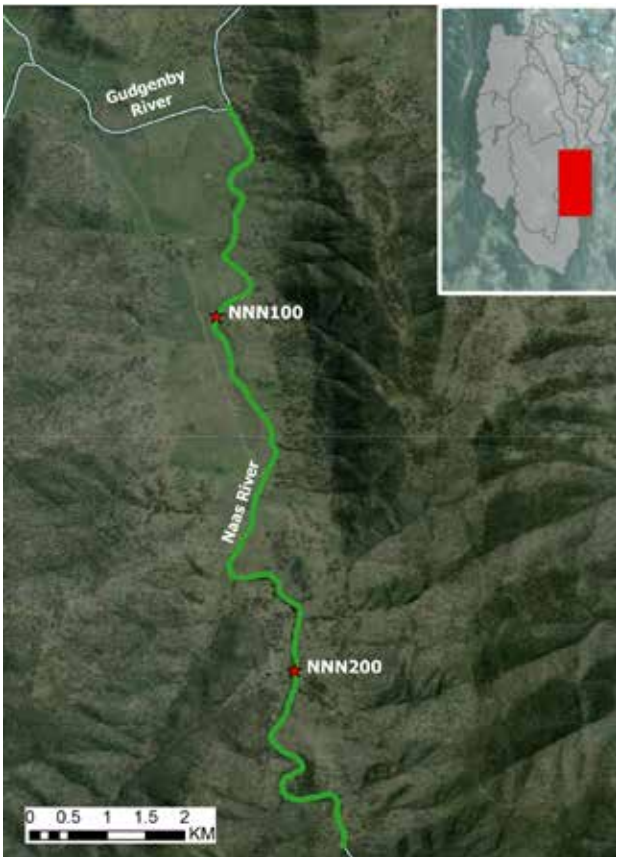
Both waterbug surveys conducted at NNN300 found low diversity. More than seven Orders of waterbugs are required to earn more than a *fair* score. That failed to occur here even though the three key pollution-sensitive Orders; stonefly, mayfly and caddisfly larvae, were found in high numbers. Extreme flows are the most likely cause.

Another wet year hampered efforts to monitor the upper Naas catchment

Naas River NAA2

Above Caloola Farm to Gudgenby River confluence

2022 CHIP Result B+ (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**24**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Fair	
Nitrate	Excellent	
Electrical Conductivity	Good	
Dissolved Oxygen	Good	
Waterbug	**Excellent**	**2**
Riparian condition	**Fair**	**2**



Reach Facts

Reach network length: approx. 6km
Dominant land uses: Rural residential, grazing

This reach runs from just above Caloola Farm, below the boundary of Namadgi National Park, to the confluence with Gudgenby River. Historic and existing land use activities have modified native vegetation with significant erosion and large amounts of sand and sediment now seen in-stream along this section of the river.

The Actions for Clean Water (ACWA) Plan sets out a strategy for improving water quality (targeting turbidity) in the upper Murrumbidgee catchment. This reach is a high priority ACWA catchment with six key erosion sites identified. The Rivers of Carbon- Naas River project is partnering with the ACT Government and landholders to reduce erosion, improve water quality, stabilise banks and increase biodiversity and this will have positive impacts on the health of this reach.

The riparian condition assessment of *fair* reflects the dominance of weedy understorey and ground cover plants. Native canopy storey is present at the upstream site but completely absent downstream. Deep rooted native species are important in riparian zones to provide shading, stabilising and filtering functions as well as organic matter inputs in upland streams which supports aquatic foodwebs.

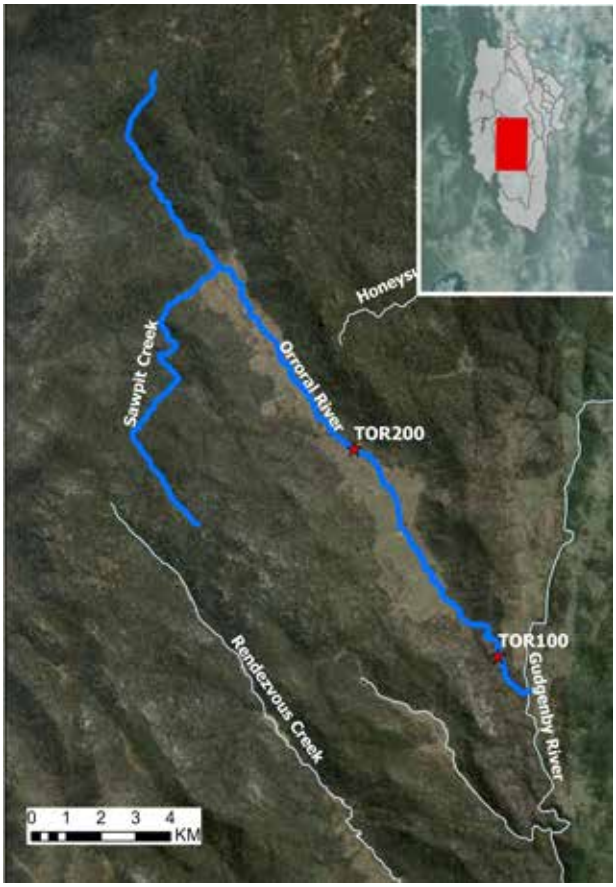
All three key pollution-sensitive Orders (stoneflies, mayflies and caddis flies) were found in both Autumn and Spring surveys with mayflies in high numbers in the Spring. Blackfly larvae, a pollution-tolerant waterbug, were also present and in very high numbers (est 1000).

Waterwatcher Sam Burns at the flooded Caloola Farm crossing (NNN200) in April

Orroral River ORR1

Headwaters to Gudgenby River confluence

2022 CHIP Result A+ (Excellent)		
2021 CHIP Result B+ (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**18**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Degraded	
Waterbug	**Excellent**	**1**
Riparian condition	**Excellent**	**1**



Reach Facts

Reach network length: approx. 26km
Dominant land uses: Conservation and Recreation

The Orroral River arises in the ranges east of the Cotter catchment in Namadgi National Park and flows east through a valley hosting an extensive upland fen wetland. This area hosts a range of submerged macrophytes (water plants) as well as large stands of Phragmites. The river then flows through rocky cascades, past Orroral campground, and ends at the confluence with the Gudgenby River.

The landscape was extensively cleared for grazing from the 1830s and from 1965 until the mid-1980s the valley hosted a NASA tracking station of which the foundations and surrounding landscaping still exists. The area near the tracking station site was the point where the Orroral Valley Fire began in January 2020.

There was a decline in dissolved oxygen concentrations from *fair* in 2021 to *degraded* in 2022. This may be due to the fact that this reach did not record such high flow events in 2022 allowing an increase in oxygen depleting processes.

The latest riparian survey conducted at the campground revealed a very healthy stretch of river, including good native canopy, shrub and groundcover coverage which are essential to provide habitat features such as hollow trees, fallen logs and leaf litter.

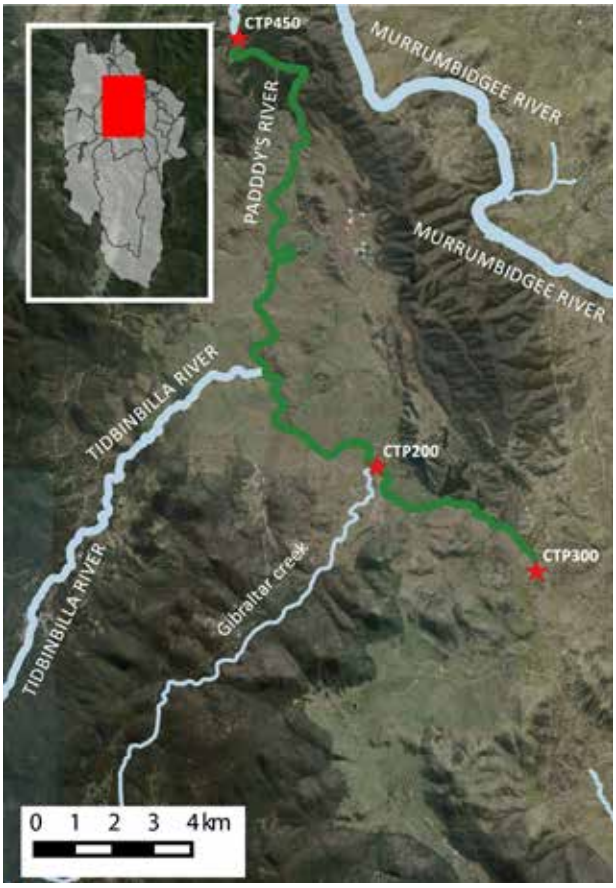
The waterbug surveys at the campground had *excellent* results, including hundreds of caddisfly larvae with eight Families recorded, including Tasimiids, with their bulging eyes, which are known to occur in clear, fast flowing, cool, mountain streams.

The Orroral River (TOR100) is showing signs of recovery from the 2020 bushfires

Paddy's River PAD1

Tidbinbilla Road bridge to Murray's Corner

2022 CHIP Result B (Good)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**35**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Fair	
Waterbug	**Good**	**2**
Riparian condition	**Poor**	**3**



Reach Facts

Reach network length: approx. 24km
Dominant land uses: Rural grazing, forestry and recreation

Paddy's River runs mostly through active grazing properties and softwood plantations that also provide public access dirt roads, popular with recreational off-road drivers. This reach covers the section below the headwaters on Booroomba Station.

The river is subject to erosion after large flooding events. The result is a sandy river bed lacking habitat complexity along much of its length, similar to the Murrumbidgee near Tharwa. Steep unstable soils in the headwaters of the Booroomba Homestead are a key contributor. Much of the riparian zone along Paddy's River lacks significant native vegetation. The Waterwatch volunteers regularly comment on the extensive amount of weeds present such as blackberry.

The continued rainfall over 2022 saw water quality slowly improve for the Paddy's River with nutrient levels and electrical conductivity remaining low. Consistent rainfall meant turbidity levels remained in the *fair* to *poor* categories most of the year with floods producing a spike of 175NTU in February. Waterwatcher Maree noted at the time a 'slippery layer' of bushfire ash which is still moving through the system two years after the fires.

There were big improvements in the waterbug scores, improving the overall CHIP score. In April there was an *excellent* score at Murray's Corner (CTP200) with eleven types found. At Flints Crossing (CTP300) 'Stream horse' mayfly nymphs (Family Coloburiscidae) were detected. These are usually only found in more upland, pristine rivers.

Ranger James Patrick helps out with waterbugs at Flint's Crossing, October 2022

Point Hut Ponds MPG1

Headwaters of Conder Creek to Murrumbidgee River confluence

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**29**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**2**
Riparian condition	**Poor**	**4**

Reach Facts

Reach network length: approx. 2.5km
Dominant land uses: Urban

The drainage line that feeds this reach, flows down through the suburbs into Conder Wetland, which then drains to Point Hut Pond, a sediment control pond in Gordon. Together they make up a stormwater system that has been engineered with flow reduction features and verge vegetation to reduce some of the negative impacts from suburban runoff. The water from this system then flows into the Murrumbidgee River just downstream of Point Hut Crossing. Conder wetland was dredged in 2021 to remove sediment and pollutant loads.

The *poor* riparian condition score reflects the absence of understory, debris and large native grasses, that make up healthy shoreline habitats, especially around the lake. The Conder Wetlands Group have been undertaking a lot of planting in their patch but were disappointed to find routine maintenance mowing had destroyed significant parts of their efforts in February. A report about this was sent to the ACT Government.

Waterwatcher Vera observed in March that the '*water is heaving with Gambusia..*' despite being completely drained and dredged less than twelve months prior. Eastern gambusia are a small, very invasive exotic fish that breed at an explosive rate in the Summer months but die back significantly during the Winter.

The dredging may have contributed to the reduced phosphorus levels this year. High turbidity was also detected after heavy rain as sediment was washed in from the surrounding suburbs.

Turbidity and unstable banks with poor edge habitat are an issue at Point Hut Pond (photo: S.Hurley)

Stranger Pond MSP1

Stranger Pond in North Bonython

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Excellent**	**24**
pH	Excellent	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Poor	
Dissolved Oxygen	Good	
Waterbug	**Poor**	**2**
Riparian condition	**Fair**	**2**

Reach Facts

Reach network area: approx. 4Ha
Dominant land uses: Urban

The 'Stranger Pond' 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 to the suburb of Bonython. Overflow enters the Murrumbidgee River at Pine Island Reserve. Waterwatch monitoring has only been conducted at Lower Stranger Pond.

This pond also has the best riparian condition score of all the southern ACT lakes, albeit only *fair*. There is a large stretch of native vegetation near the dam end. Here can be found a dense stand of native trees, understory shrubs and grass tussocks. The build-up of plant debris is also largely undisturbed. This is vital for a healthy water edge habitat.

Water quality remained *excellent* in this pond. The small size of the surrounding catchment compared to our other southern lakes shields it somewhat from large stormwater surges after heavy rain. That said, there was still an increase in electrical conductivity as urban pollutants were washed from concrete drains and roads.

Despite the *excellent* water quality and *fair* riparian condition, waterbug surveys this year were worse than the other lakes in Tuggeranong. This was due to a combination of a low diversity of Orders in Autumn and a low number of pollution-sensitive waterbugs such as mayfly and caddisfly in Spring. Mostly pollution-tolerant types were found in the latter survey, including lots of introduced New Zealand mud snails *Potamopyrgus antipodarum*.

Waterwatcher Tony helps out Martin with the Spring waterbug survey at Stranger Pond

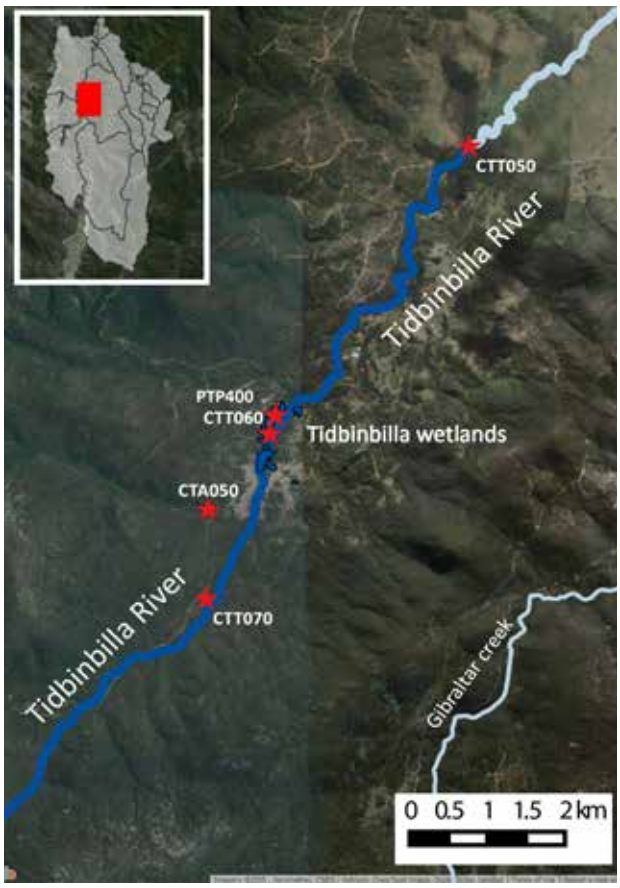
Tidbinbilla River TID1

Headwaters of Tidbinbilla River & Ashbrook Ck to Gilmores Rd crossing

2022 CHIP Result A (Excellent)

2021 CHIP Result B+ (Good)

Parameter	Rating	No. Survey
Water quality	**Excellent**	**48**
pH	Good	
Turbidity	Excellent	
Phosphorus	Excellent	
Nitrate	Excellent	
Electrical Conductivity	Excellent	
Dissolved Oxygen	Fair	
Waterbug	**Excellent**	**2**
Riparian condition	**Good**	**5**



Reach Facts

Reach network length: approx. 8.5km
Dominant land uses: Conservation, tourism and rural grazing

This reach covers most of the Tidbinbilla River and the adjacent artificial wetlands (the 'Sanctuary'). Ashbrook Creek is a small upland stream in the reserve's west. The rich and diverse riparian condition along most of this reach is reflective of a well-managed nature reserve.

The riparian assessment of the Tidbinbilla reach is based on surveys at one of the wetlands as well as river sites. The former brings down the average by having a very low canopy width to water channel ratio. This is a common issue with pond and lakes.

In 2022 all Waterwatch monitoring in the Sanctuary was conducted in the main wetland section (Pond 4 - PTP400). This is more reflective of the Sanctuary's health than in previous years, when an ephemeral pond at the end of the five-pond system was used.

Good flows through the river and wetlands kept water quality in *excellent* condition. Ashbrook Creek, again, had low dissolved oxygen saturation, dropping to only 50% at four times over the year. The pH levels were also regularly low at most sites, getting down to 5.5 over the cooler months at the two 'Sanctuary' sites (CTT060 and PTP400).

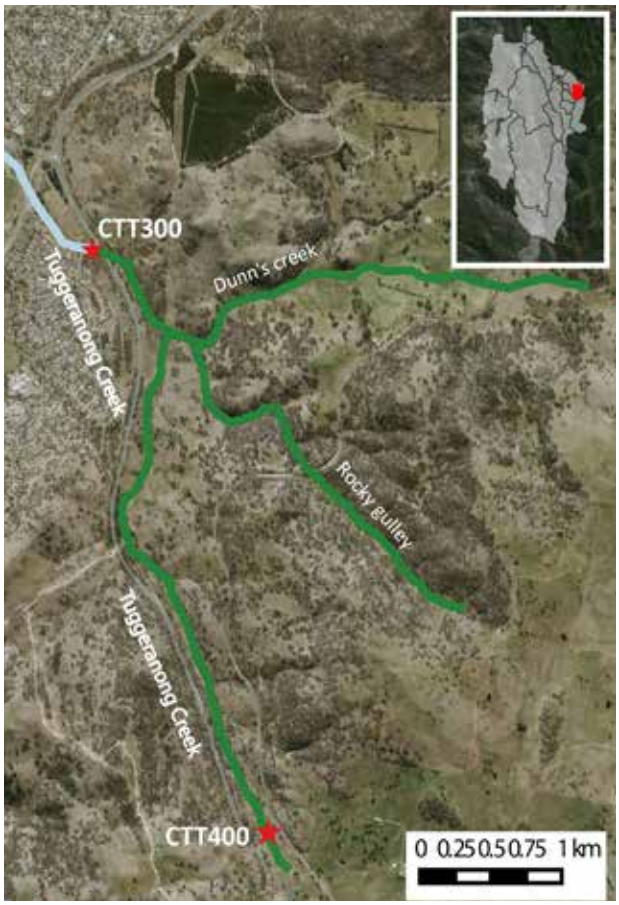
The waterbug score leapt from *fair* in 2021 to *excellent* in 2022 as large numbers of very pollution-sensitive Orders returned to the Tidbinbilla River. There were hundreds of stonefly and mayfly nymphs in Spring along with 'toe biters' (Order Megaloptera), a large, top-order predatory waterbug that lives amongst cobbles of fast-flowing streams. These are all positive signs that the river is recovering well from the impact of the fires.

The lower Tidbinbilla River site (CTT050) is heavily distrubed and has a shallow, sandy substrate

Tuggeranong Creek, Upper TUG1

Headwaters of Tuggeranong Creek catchment to Theodore

2022 CHIP Result B+ (Good)		
2021 CHIP Result B (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**21**
pH	Good	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Fair	
Dissolved Oxygen	Fair	
Waterbug	**Excellent**	**1**
Riparian condition	**Poor**	**2**



Reach Facts

Reach network length: Monks Creek (upper arm 3.2km), Tuggeranong Creek (lower arm) 4km
Dominant land uses: Rural grazing

The system is fed from Monk's and Dunn's creeks to the east and Tuggeranong Creek to the south. The Tuggeranong Creek arm runs adjacent to the Monaro Highway. The upper creek arises from farming country with smooth, Ignimbrite bedrock.

CTT400 at the headwaters, has no trees and little understory other than weeds. The riparian vegetation at the downstream site is almost exclusively poplars with many of their wilding saplings as the understory. This can make surveying water bugs in Autumn difficult due to the extensive leaf litter. The lower site, next to the Monaro Highway, is a hotspot for frequent rubbish dumping.

There were high flows and flooding in Spring, but for most of the year flows were low to average which led to a build-up of organic matter. This may have contributed to the dissolved oxygen levels which was down on the previous year. While turbidity overall was *excellent*, high flows in both August and November saw Waterwatcher Vera note readings of 100 and 145NTU respectively at CTT300, indicating an impacted landscape upstream.

An *excellent* score for waterbugs for the second year in a row was due to good diversity, with overall numbers even better than last year. A high number of mayfly nymphs from three different Families were detected plus other key pollution-sensitive Orders including stonefly nymphs and caddisfly larvae.

Longtime Waterwatcher Vera Kutz monitoring the upper Tuggeranong Creek (CTT300)

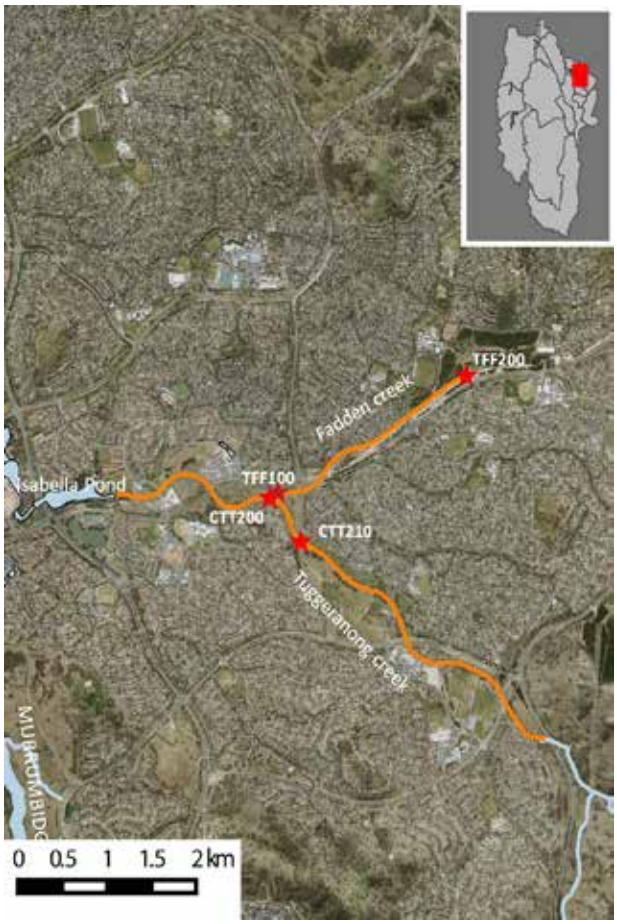
Tuggeranong Creek, Middle TUG2

Concrete drain system upstream of Isabella Pond

2022 CHIP Result D+ (Poor)

2021 CHIP Result D (Poor)

Parameter	Rating	No. Survey
Water quality	**Good**	**23**
pH	Good	
Turbidity	Excellent	
Phosphorus	Good	
Nitrate	Degraded	
Electrical Conductivity	Poor	
Dissolved Oxygen	Fair	
Waterbug	**Degraded**	**2**
Riparian condition	**Degraded**	**4**



Reach Facts

Reach network length: approx. 8km
Dominant land uses: Urban.

This reach consists of a Y shaped network of two concrete stormwater channels. The main arm runs north west from Leinhop Street in Theodore. This joins another channel flowing south west from Fadden near Isabella Drive where the channel then flows into Isabella Pond.

This reach consists entirely of concrete and has no riparian vegetation, some algal filaments, and almost no aquatic organisms. As a result CHIP assessments of this reach really only vary based on measured water quality. Consequently, the highest score this reach can attain is *fair* if all the water quality parameters are *excellent*. This reach is important in demonstrating the crucial roles waterbug and riparian surveys play in assessing waterway health. A concrete drain is a barren habitat.

The flushing rainfall this year had a positive effect on turbidity and dissolved oxygen levels. High concentrations of dissolved salts and minerals, measured as electrical conductivity, was detected in both drains and high nitrate loads continued to be an issue from the Fadden arm with a spike in nitrates (7.5mg/L) measured there in March.

A solitary stonefly nymph, from the Family Notonemouridae, was caught in the fast-flowing Tuggeranong Creek drain arm in September. This is one of the most pollution-sensitive waterbugs and was most likely flushed down from the naturalised upper section of the creek (TUG1). Pollution tolerant springtails and bloodworms are often the only creatures found here.

The confluence of the two main stormwater drains.

Tuggeranong Creek, Lower TUG3

Tuggeranong Creek to Murrumbidgee River confluence

2022 CHIP Result C+ (Fair)		
2021 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**7**
pH	Excellent	
Turbidity	Good	
Phosphorus	Fair	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Fair	
Waterbug	**Poor**	**2**
Riparian condition	**Fair**	**1**

Reach Facts

Reach network length: approx. 1.8km
Dominant land uses: Suburban reserve

This reach includes the last natural stretch of Tuggeranong Creek fed by Lake Tuggeranong. The creek enters the Murrumbidgee River two kilometres downstream of Pine Island Reserve.

Although well lined with Casuarinas, most of the understory along the creek consists of woody weeds and invasive ground cover species. In-stream the creek was heavily overgrown with algae for most of the year. This was driven by the high levels of nutrients in the stormwater from the surrounding catchment.

Phosphorus continues to be an issue, being detected in high concentrations at times and dissolved oxygen levels were lower, affecting the overall water quality score. The elevated electrical conductivity levels detected upstream, also persisted here. On a good note, the heavy nitrate loads coming from the concrete stormwater systems did not continue beyond Lake Tuggeranong. This reminds us of the vital role Canberra's urban lakes can play in protecting the Murrumbidgee River from urban pollution in times of high rainfall.

A decline in the waterbug score this year was due in part to low diversity in May and good diversity but low abundance in October. The majority of waterbugs found in both surveys were very tolerant to pollution. An unusual snail, rarely found in the catchment, was caught during the October survey. It had well-defined ridges on its shell and was later identified as a native *Glyptophysa aliciae*.

Tuggeranong Creek below the dam wall was flowing well in October with lots of available bug habitat

Yass Catchment Facts

The Yass catchment is approximately 2,800km^2 , and is situated to the north of the ACT. It is made up of two major rivers. The first is the Yass River that has its headwaters approximately 100km to the southeast around Wamboin. The river flows northwest past Sutton, through Gundaroo and continues on to the township of Yass. It then flows through steep gorge country before entering Burrinjuck Dam from the east. The major tributaries of the Yass River include Brooks Creek, Gundaroo Creek, Murrumbateman Creek, Dicks Creek and Manton Creek. This is Ngunnawal Country.

The second major river is the Murrumbidgee River that becomes part of the Yass catchment (in terms of the CHIP report) below the confluence with Ginninderra Creek just after both waterways exit the ACT. The Murrumbidgee runs north through Wallaroo and Cavan, to the west of Murrumbateman, before entering Burrinjuck Dam from the south. This lower section of the Murrumbidgee has large sand deposits resulting from reduced flows and the impounded waters of Lake Burrinjuck. The natural river bed is smothered by the sand creating wide shallow sections with little or no in-stream structure.

A large portion of this catchment is cleared grazing land and, as a result, has issues with dryland salinity and erosion. Many of these issues could be ameliorated through stock exclusion and the regeneration of the riparian zone. This is occurring on a number of fronts throughout the region with the Yass Area Network of Landcare Groups (YAN) playing a major role.

Yass Catchment Health Summary

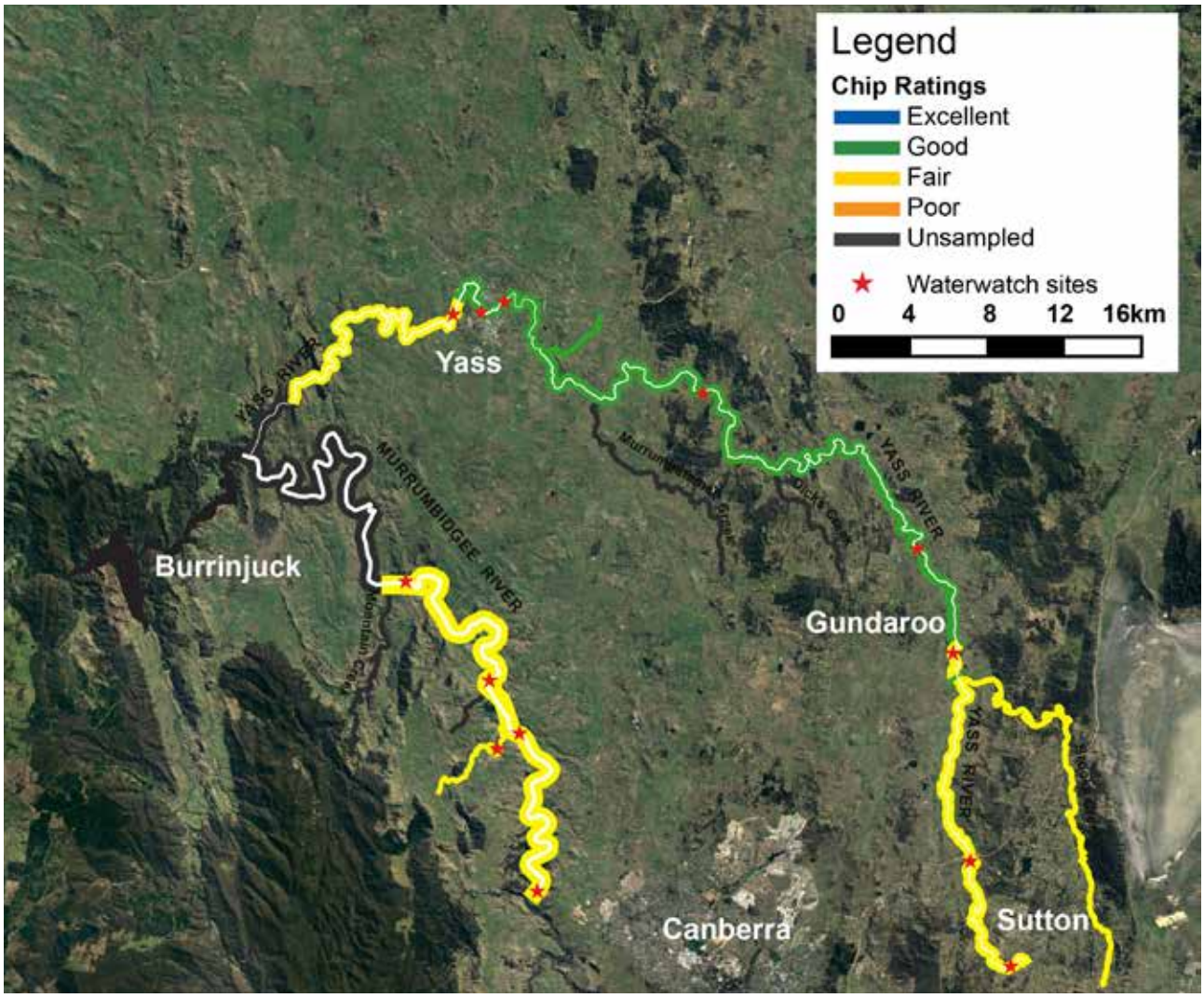
This is the eighth year that data has been collected in the Yass catchment - a great credit to a small but dedicated band of volunteers in this region.

Three reaches showed improvements this year, one presented the same score as 2021, and two showed declines. The Yass River and the lower Murrumbidgee River both experienced high flows and some significant flooding throughout 2022 and this contributed to both these improvements and declines.

Of all the parameters, it was waterbugs that drove change the most in 2022. In the upper and middle reaches of the Yass River (YAS1-YAS3), waterbugs showed signs of improvement. Even in YAS1 , where the scores didn't change, there were pollution-sensitive stoneflies detected for the first time since Waterwatch monitoring began here. Stoneflies were also found in YAS2 where diversity and abundance of waterbugs displayed promising signs The diluting effects of the high flows on parameters like electrical conductivity may have also helped with the bug results. Conversely, YAS4 and the two Murrumbidgee reaches (CMM12 and 13) both had declines in waterbug scores. High flows that submerged and scoured out waterbug habitat appears to be the main cause.

The high flows had a positive impact on water quality in the Murrumbidgee River as ash and sediment from the 2020 bushfires continued to be flushed through the system. Turbidity, phosphorus and dissolved oxygen all showed improvements on the lower Murrumbidgee reach (CMM13).

Water quality was not as promising on the lower end of the Yass River. Flooding was quite destructive in both YAS3 and YAS4 with erosion noted, willows uprooted and large boulders moved downstream. Phosphorus and turbidity levels increased at times as a result of the constant high flows and electrical conductivity was getting higher when the river levels went down. This all appears to be a sign that, while high flows have improved water quality in this catchment in recent years, the underlying land management issues still exist and will become more apparent as conditions again dry out.



Murrumbidgee River CMM12

Ginninderra Creek confluence to above Mullion Creek confluence

2022 CHIP Result C+ (Fair)		
2021 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**8**
pH	Excellent	
Turbidity	Excellent	
Total Phosphorus	Excellent	
Nitrate	Degraded	
Electrical Conductivity	Fair	
Dissolved Oxygen	Excellent	
Waterbug	**Poor**	**2**
Riparian condition	**Fair**	**2**

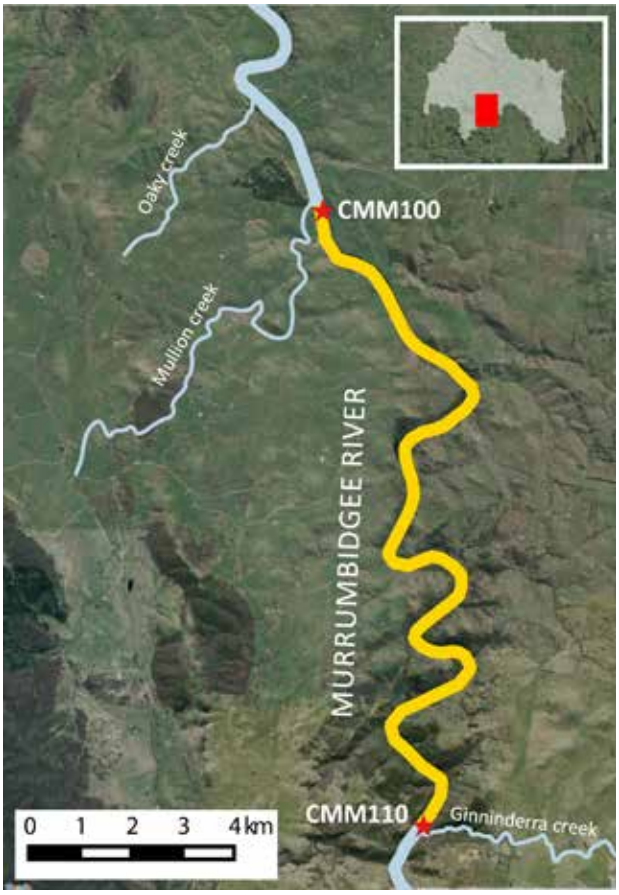
Reach Facts

Reach network length: approx. 18km
Dominant land uses: Grazing, conservation

This Murrumbidgee River reach starts at the confluence with Ginninderra Creek and ends above the confluence with Mullion Creek in Wallaroo. The riparian condition varies considerably through this reach. The upper section contains some of the most intact remnant patches in the area with steep rough terrain providing refuge for native species. In contrast the lower section is dominated by exotic weed species and heavily impacted by sheep farms. In a few notable places, private landowners are undertaking riparian vegetation plantings to improve streambank condition.

The most concerning parameter in this reach over the past few years is nitrate, where concentrations have reached up to 30mg/L (*degraded* levels are >2.6mg/L). The source of this is most likely the Lower Molonglo Water Quality Control Centre located upstream. Continuing high flows throughout 2022 have seen small improvements in water quality, with lower turbidity than in 2021 as ash and sediment from the 2020 bushfires are flushed through the system.

The high flows, however, have also likely affected the low numbers and diversity of waterbugs, with only six and seven Orders found at the Autumn and Spring surveys, respectively. Despite this, it was encouraging to find a stonefly during the Spring survey, a first for this reach. This is another indication that the water quality has improved enough in recent years to support these pollution-sensitive waterbugs.



High water levels above CMM100 made sampling difficult the during Spring bug survey

Murrumbidgee River CMM13

Mullion Creek confluence to Taemas Bridge above Burrinjuck Dam

2022 CHIP Result C+ (Fair)

2021 CHIP Result C (Fair)

Parameter	Rating	No. Survey
Water quality	**Excellent**	**23**
pH	Excellent	
Turbidity	Excellent	
Total Phosphorus	Excellent	
Nitrate	Good	
Electrical Conductivity	Fair	
Dissolved Oxygen	Good	
Waterbug	**Degraded**	**2**
Riparian condition	**Fair**	**3**

Reach Facts

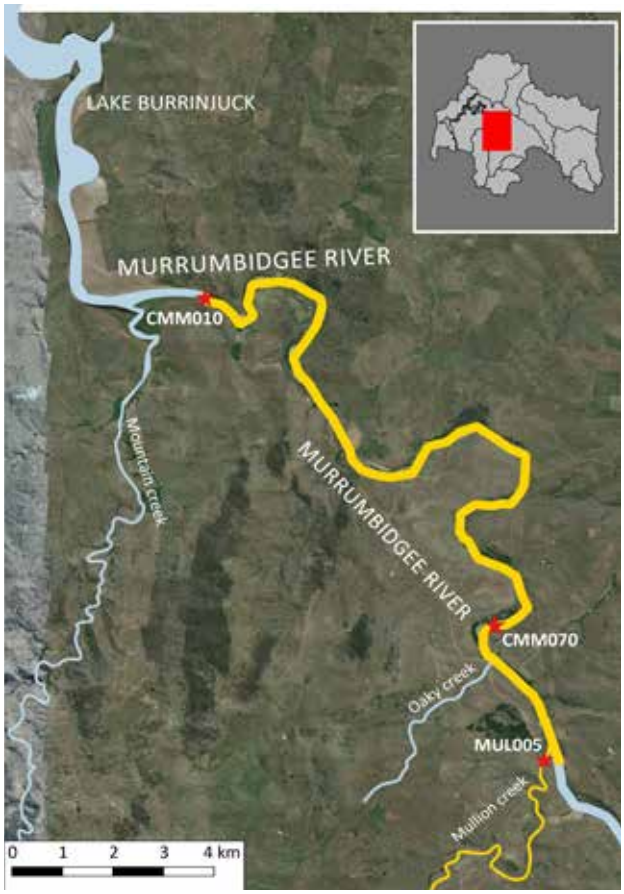
Reach network length: approx. 20km
Dominant land uses: Rural

This reach is the most downstream of the 13 reaches on the Murrumbidgee River. The bottom site at Taemas Bridge is immediately upstream of the impounded waters of Lake Burrinjuck.

Much of this catchment is cleared grazing land, with poor in-stream habitat and a narrow and degraded riparian zone. Stock have direct access to the river in many places, further impacting condition. These land use practices and the low flows resulting from the dam, have produced large 'sand slugs' (a large intrusion of sand within a river channel) in the downstream section of this reach.

The water level at Taemas Bridge (CMM010) remained very high throughout 2022, with water quality sampling and waterbug surveys being carried out level with the trees near the bridge instead of at the usual site a couple of metres down the river bank. This reduced the amount of aquatic vegetation available as habitat for waterbugs, which helps to explain the low diversity and abundance detected during the waterbug surveys.

Despite a lower waterbug score, the overall CHIP score improved due to improvements in turbidity and phosphorus concentrations and a very positive jump in dissolved oxygen levels. Riparian vegetation scores also improved this year.

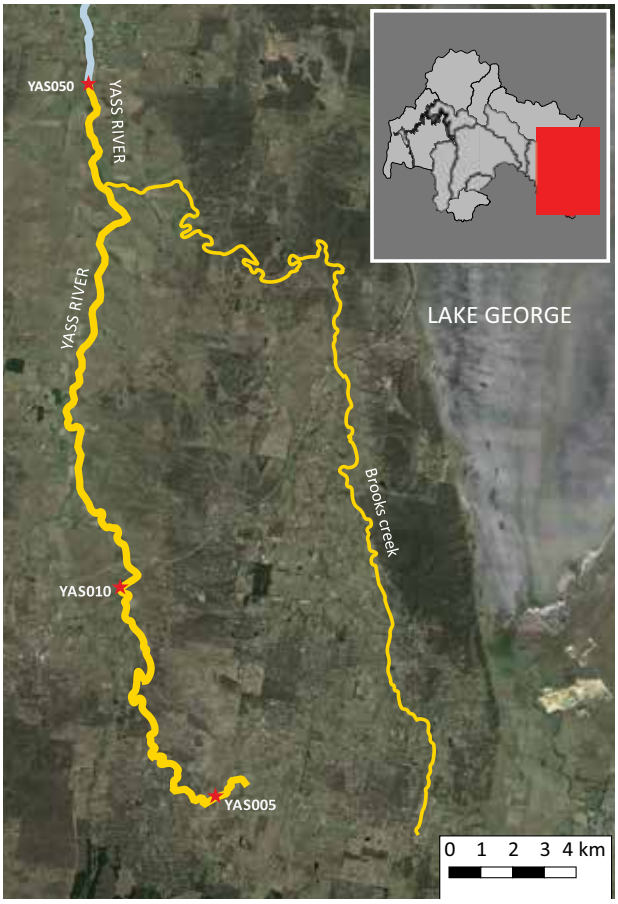


Waterwatcher Shaun Young at CMM070

Yass River YAS1

Headwaters to Brooks Creek confluence, including Brooks Creek

2022 CHIP Result C+ (Fair)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**21**
pH	Excellent	
Turbidity	Good	
Total Phosphorus	Good	
Nitrate	Excellent	
Electrical Conductivity	Poor	
Dissolved Oxygen	Degraded	
Waterbug	**Fair**	**4**
Riparian condition	**Poor**	**3**



Reach Facts

Reach length: approx. 60km
Dominant land uses: Rural, rural residential

The upper Yass River and Brooks Creek represent the top of the Yass River catchment. Although good ground cover is present throughout this reach, with the presence of tussock grasses, the overall amount of native vegetation is still limited.

Electrical conductivity, the salts and minerals present in the water, are often at high concentrations in the Yass River, giving *poor* or *degraded* scores. This is partly due to historical land use and partly underlying geology. There is a clear correlation in the Yass River between low flows and high electrical conductivity levels. While the high flows of late Winter and early Spring, diluted concentrations and improved results, lower flows at the beginning and end of the year saw readings spike. Waterwatchers Carol and Clive at YAS010 were so surprised to get a reading of 920µS/cm in March (>404µS/cm is *degraded*) when the river was low, that Clive tested it three times to make sure.

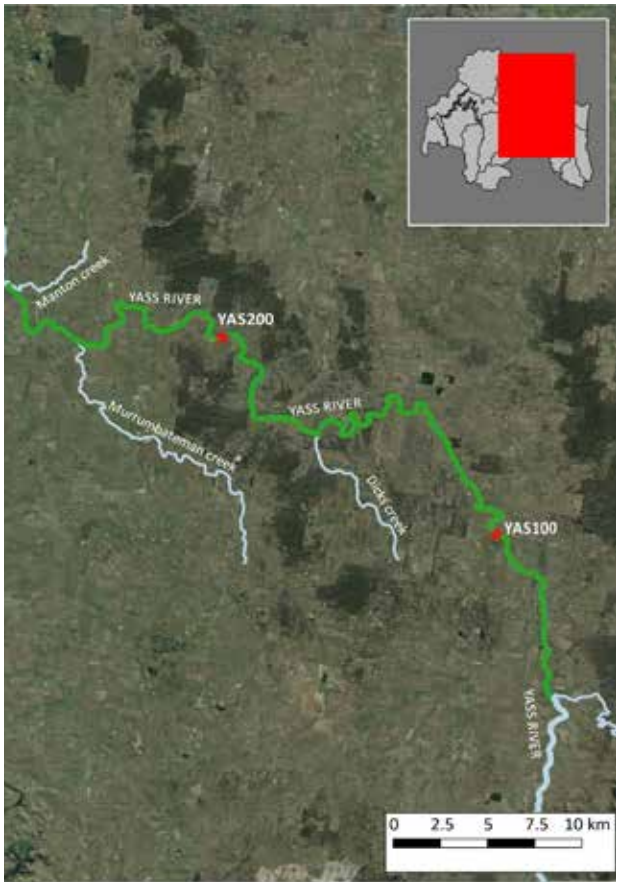
Overall, however, the condition of this reach remained very similar to 2021, with water quality, waterbug, and riparian vegetation scores showing little change. An encouraging sign in the Spring waterbug survey was the presence of a pollution-sensitive stonefly nymphs (Order: Gripopterygidae) detected for the first time in this reach, along with similarly sensitive mayflies and caddisflies.

The Yass River (YAS050) just upstream of Gundaroo township

Yass River YAS2

Dicks Creek confluence to Manton Creek confluence

2022 CHIP Result B- (Good)		
2021 CHIP Result C+ (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**13**
pH	Excellent	
Turbidity	Good	
Total Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Degraded	
Waterbug	**Good**	**2**
Riparian condition	**Fair**	**2**



Reach Facts

Reach length: approx. 30km
Dominant land uses: Rural

This mid-section of the Yass River contains the major tributaries of the Murrumbateman and Manton creeks. The catchment is largely cleared and used for grazing. Riparian condition is generally poor, with pasture improvements right up to the river bank and stock having regular access to the river . Erosion and in-stream sedimentation, are issues in this reach, as is high electrical conductivity due to a combination of historical land use and geology.

A healthy and highly functional riparian corridor can be found at 'Goldenholm' (YAS200) with native canopy cover including River red gums, midstorey including Acacias and intact groundcover all present. Conversely Booth's Crossing (YAS100) has minimal canopy cover and depauperate groundcover, pulling the overall riparian score for the reach down to a *fair* rating.

2022 saw a lot of rain, with the river repeatedly flooding and maintaining medium to high flows all year. The water quality score showed a slight decline compared to 2021, with low dissolved oxygen levels, increased nitrates and electrical conductivity staying above 400µS/cm for all but one month throughout the year. There was, however, good waterbug diversity with eleven different Orders detected in the Spring surveys. This included stoneflies, which is the first record of this pollution sensitive waterbug for this site. Stoneflies were also detected in YAS1 for the first time this year, a positive sign for the Yass River in general.

Lots of little helpers at 'Goldenholm' (YAS200) during the Spring waterbug survey

Yass River YAS3

Yass township

2022 CHIP Result B- (Good)		
2021 CHIP Result C- (Fair)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**12**
pH	Excellent	
Turbidity	Fair	
Phosphorus	Good	
Nitrate	Good	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Excellent	
Waterbug	**Fair**	**2**
Riparian condition	**Fair**	**2**

Reach Facts

Reach network length: approx. 10km
Dominant land uses: Urban/Rural Fringe

This section of the Yass River includes the township of Yass. Flow is heavily influenced by Yass Dam located just above the township, as well as runoff from the surrounding urban landscape. The township of Yass was named after Yarrh or Yharr, the word for running water in the Ngunnawal language.

There is ongoing habitat restoration works occurring in the Yass Gorge at the top of the reach. The gorge (YAS350) is a heritage site and one of the most conserved sections of Yass River, with good representation of large, native trees, shrubs and lomandra shrubs. The Friends of Yass Gorge have been instrumental in restoring this landscape and controlling weeds.

The presence of in-stream vegetation in YAS370, such as native Ribbon weed, serves as habitat for waterbugs, fish and turtles. Waterbug diversity showed an improvement in 2022, with eight different Orders detected in both the Autumn and Spring surveys. Native carp gudgeon were also found during both waterbug surveys, with invasive Eastern gambusia recorded at the Autumn survey.

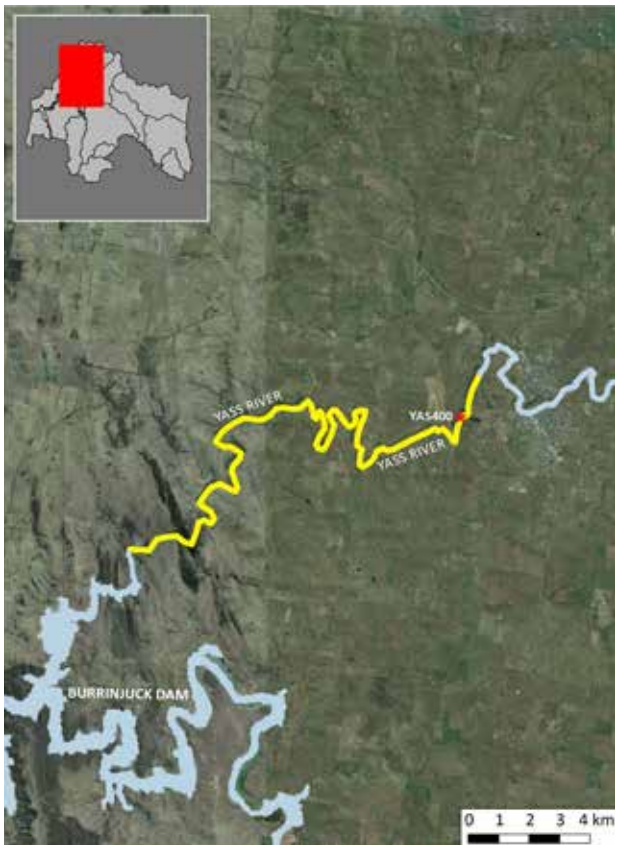
High flows and flooding was observed throughout the year with Waterwatcher Rebecca making several notes of eroding banks as well as deposits of silt and debris including two large trees falling into the river near her site, YAS370. Waterwatchers recorded turbidity as high as 55NTU and a huge range in electrical conductivity readings of 330µS/cm- 1430µS/cm.

Turbidity and unstable riverbanks were noted at YAS370 throughout 2022

Yass River YAS4

Hattons Corner to Burrinjuck Dam

2022 CHIP Result C+ (Fair)		
2021 CHIP Result B- (Good)		
Parameter	**Rating**	**No. Survey**
Water quality	**Good**	**7**
pH	Excellent	
Turbidity	Good	
Phosphorus	Good	
Nitrate	Poor	
Electrical Conductivity	Degraded	
Dissolved Oxygen	Excellent	
Waterbug	**Poor**	**2**
Riparian condition	**Fair**	**1**



Reach Facts

Reach network length: approx. 23km
Dominant land uses: Rural Fringe

This downstream section of the Yass River runs through gorge country and farmlands before flowing into Lake Burrinjuck. This reach is marked by its scenic beauty and significant geological history. The Hume Limestone, which caps the escarpment above the river at Hattons Corner, is particularly rich in fossils. Habitat restoration projects are underway, led by landowners below the township. This should have a positive impact on the catchment health over the long term.

Despite the presence of reeds along the Yass River and some patches of native tree regeneration, most of the riparian zone is generally lacking good canopy cover and shrubs. This is necessary to provide shade, erosion control, and habitat for birds and other fauna. Willows and blackberries were noted as having lost their leaves by Waterwatcher Rebecca at YAS400 in June.

In 2022, continuing wet conditions with multiple flood events caused erosion of the riverbanks, with trees uprooted and rocks shifted by the strength of the flows. The high water levels also submerged most of the in-stream vegetation which provides habitat for waterbugs. The waterbug surveys recorded fewer bug types than in previous years, with eight different Orders detected.

Water quality also showed a decline, with the noticeably brown and murky samples giving higher than usual turbidity and phosphorus readings. Electrical conductivity concentrations stayed in the *degraded* range above 400µS/cm all year long.

Willows and large rocks were mobilised during floods at Hattons Corner, March 2022 (photo: R.Widdows)

Special Report

The relationship between rainfall and water quality depends on land use and riparian condition

By Isobel Booksmythe, Citizen Science Data Analyst, ACT Government.

Background

Upper Murrumbidgee Waterwatch (UMWW) is a long-running citizen science program that aims to facilitate community engagement and education through the monitoring and care of local waterways, and to use the data collected by volunteers to inform policy and catchment management. A key output of this program is the annual Catchment Health Indicator Program (CHIP) report, which combines volunteer-collected data on water quality with assessments of waterbug diversity and riparian vegetation condition to calculate an annual health score for every monitored reach in the catchment. The purpose of the CHIP report is to give the community a comprehensive overview of waterway and riparian health issues in the catchment, as well as to provide an ongoing baseline assessment of catchment health to inform natural resource managers and policy makers.

Following a University of Canberra review to assess the quality of Waterwatch data (Harrison et al. 2013), UMWW implemented the current reach-based reporting framework and the composite CHIP score approach to reporting on the health of the catchment. This, along with regular quality assurance/quality control workshops and ongoing review of data analysis methods, has resulted in a more consistent, quantitative record of catchment health over the past eight years. The CHIP is recognised in the *ACT Water Strategy 2014-44* as a way to 'enhance knowledge and spatial planning for water and catchment management' and it contributes to multiple monitoring programs and reports within the ACT Government and Icon Water.

Despite recognition of the value of the data collected through the Waterwatch program, it is currently used only in reporting the state of the catchment at snapshots in time. An unexplored potential for this long-term data set is to investigate trends and changes over time, as well as to identify relationships with other environmental and management factors and possible influences on water quality. This report presents a preliminary case study demonstrating how Waterwatch data can be used for a more in-depth understanding of catchment health.

Case study: The relationship between rainfall and water quality

Water quality is determined by a wide range of different natural processes and human management influences. A key factor is rainfall, which is generally expected to improve water quality by diluting concentrations of nutrients and salts, and by increasing flows helping to increase dissolved oxygen levels as well as potentially flushing sediment and organic matter through streams and waterways to ponds and wetlands.

However, runoff from rainfall can also transport nutrients and sediment from the wider catchment into waterways, depending on the catchment's ability to absorb and filter the rainfall it receives. Urban waterways are highly modified environments that face unique challenges, including high nutrient and pollution inputs, with drastically reduced and altered vegetation and extensive impervious surfaces decreasing the natural water filtration capabilities of the surrounding area.

This raises the question – do we see a uniform improvement in water quality across the catchment in wetter years, or can we detect differences in the response to rainfall between sites with different land uses and riparian vegetation condition? The Waterwatch data can be used to investigate this possibility, as Waterwatch sites cover a diverse array of land uses and vegetation health scores. By looking at the annual changes in water quality at these different sites over the last eight years, which have seen a lot of variability in annual rainfall, we can start to untangle some of the details of how our waterways respond to rain.

This case study explores how land use and riparian vegetation condition have influenced the relationship between annual rainfall and water quality scores in the Upper Murrumbidgee catchment between 2015 and 2022.

Methods

Annual water quality and riparian vegetation condition (RARC) scores were calculated for each reach following the standard CHIP method (see Appendix II), for every year from 2015 to 2022. Annual rainfall data from 1963 to 2022 was downloaded from the Bureau of Meteorology website and used to calculate the 70-year average annual rainfall. This long-term average was then used to calculate the residual rainfall for each year (the standardized difference from the long-term average; i.e., how much wetter or drier than usual is each year). Land use information for each reach was compiled from reach descriptions in the CHIP report, and reaches were classified as being in areas with some urban land use or areas with minimal urban land use (i.e., those with predominantly conservation and/or rural land uses).

For analyses of how water quality scores respond to rainfall, a 'change in water quality' index was calculated by taking a reach's score for a given year and subtracting its score for the previous year. A positive value for this index indicates that the score has increased (i.e., worsened, because a larger number represents a worse score under the CHIP method) while a negative value indicates that the score has decreased (i.e., improved). An index for the change in residual rainfall was calculated using the same approach.

The analyses used linear mixed-effects models to find the statistical relationship between the change in water quality and the change in rainfall, taking into account the land use classification of each reach and its riparian condition score, and controlling for differences among years in the absolute amount of rainfall.

Note that the results of these analyses summarise the data to describe average effects. Within these broad trends, individual reaches will not necessarily follow these patterns in any given year, as many additional influences contribute to determining the year-to-year condition of a reach.

Results and discussion

Urban land use affects how reaches' water quality scores respond to rain (Fig. 1). An increase in annual rainfall compared to the previous year is associated with an improvement in the average water quality score, and a decrease in annual rainfall is associated with a decline in average water quality --- but only for non-urban reaches. For urban reaches the opposite is true: having more rain than the previous year is associated with worse water quality, and less rain than the previous year is associated with improvements in water quality scores. This suggests that while going from a dry year to a wet year has the expected positive effect on water quality in non-urban waterways, in urban environments these are outweighed by the negative effects, such as increasing inputs of nutrients and other pollutants.

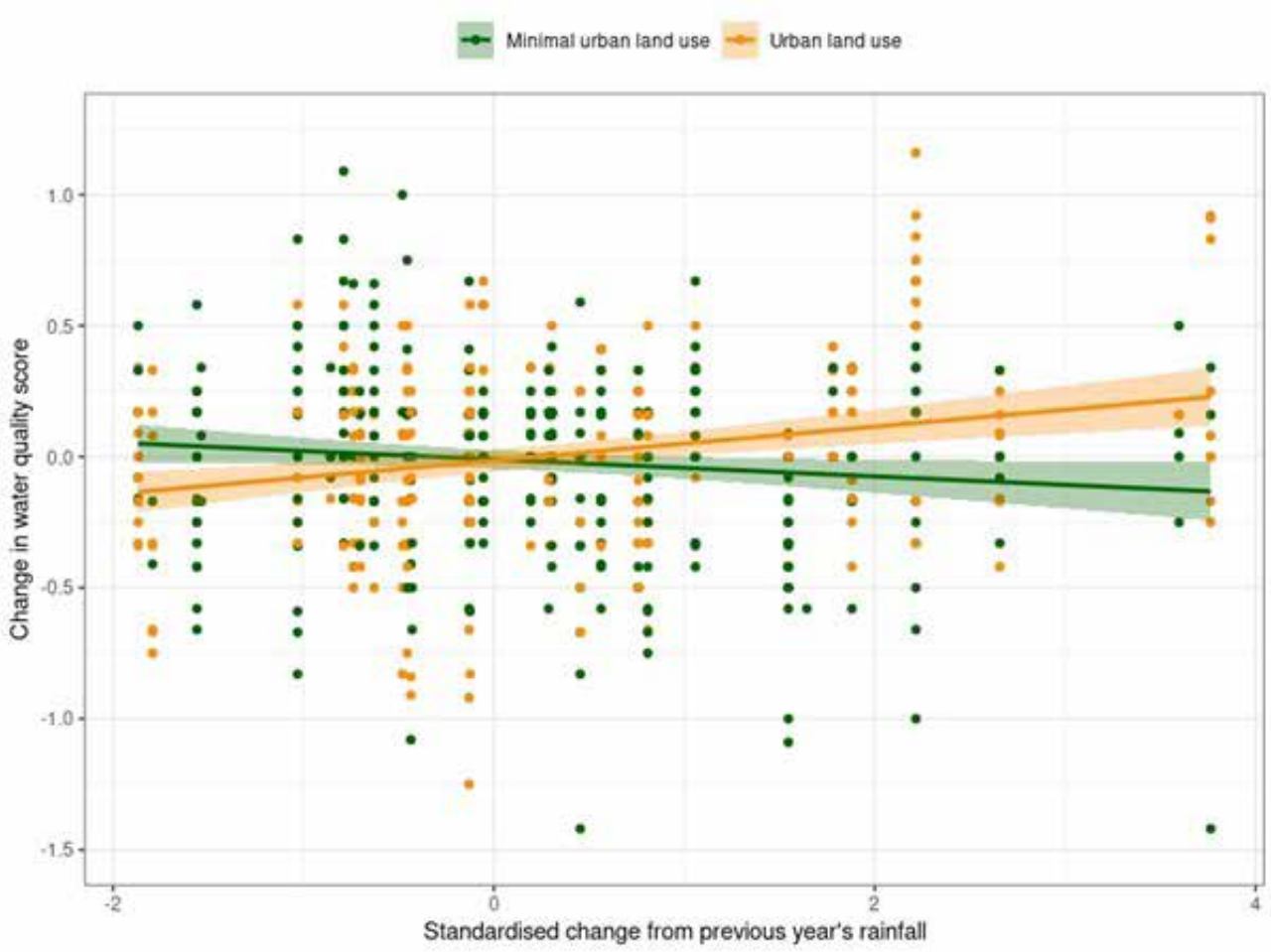


Figure 1. Change in water quality between years is associated with annual change in rainfall, but this relationship differs for reaches with urban vs. non-urban land use. Each dot represents an individual reach in a particular year. Lines show the average relationship between the change in rainfall and change in water quality for urban (orange) and non-urban reaches (green). Note that a positive change in water quality score (numbers above the 0 line) indicates a decline in water quality (because a larger number is a worse score). For non-urban reaches, increasing rainfall compared to the previous year is associated with an improvement in water quality scores (green line slopes down to the right). For urban reaches, increasing rainfall is associated with a decline in water quality scores (orange line slopes up to the right).

Riparian vegetation condition also influences how water quality scores respond to rainfall (Fig. 2). For reaches with good riparian vegetation condition, an increase in rainfall from the previous year is associated with an average improvement in water quality scores. As riparian vegetation condition declines, this effect of rainfall on water quality shifts from positive to negative. For reaches with poor riparian vegetation condition, increases in annual rainfall are associated with declines in the average water quality score. Similarly to the effect of urban environments, this may reflect that waterways with degraded riparian vegetation have lower resilience to varying climatic conditions, and are more vulnerable to processes such as erosion and pollution than waterways with more intact riparian vegetation.

These results are consistent with our understanding of how urbanisation and modified riparian vegetation can affect catchment functions, for example altering catchments' ability to capture nutrients and sediment from rainfall runoff before it enters waterways. These are preliminary analyses performed at a relatively coarse temporal and spatial scale, and it is important not to over-interpret correlational associations. However, this case study clearly demonstrates the potential for Waterwatch data to be used in more detailed analyses, aimed at understanding the environmental and management factors that affect the water quality scores observed across the catchment.

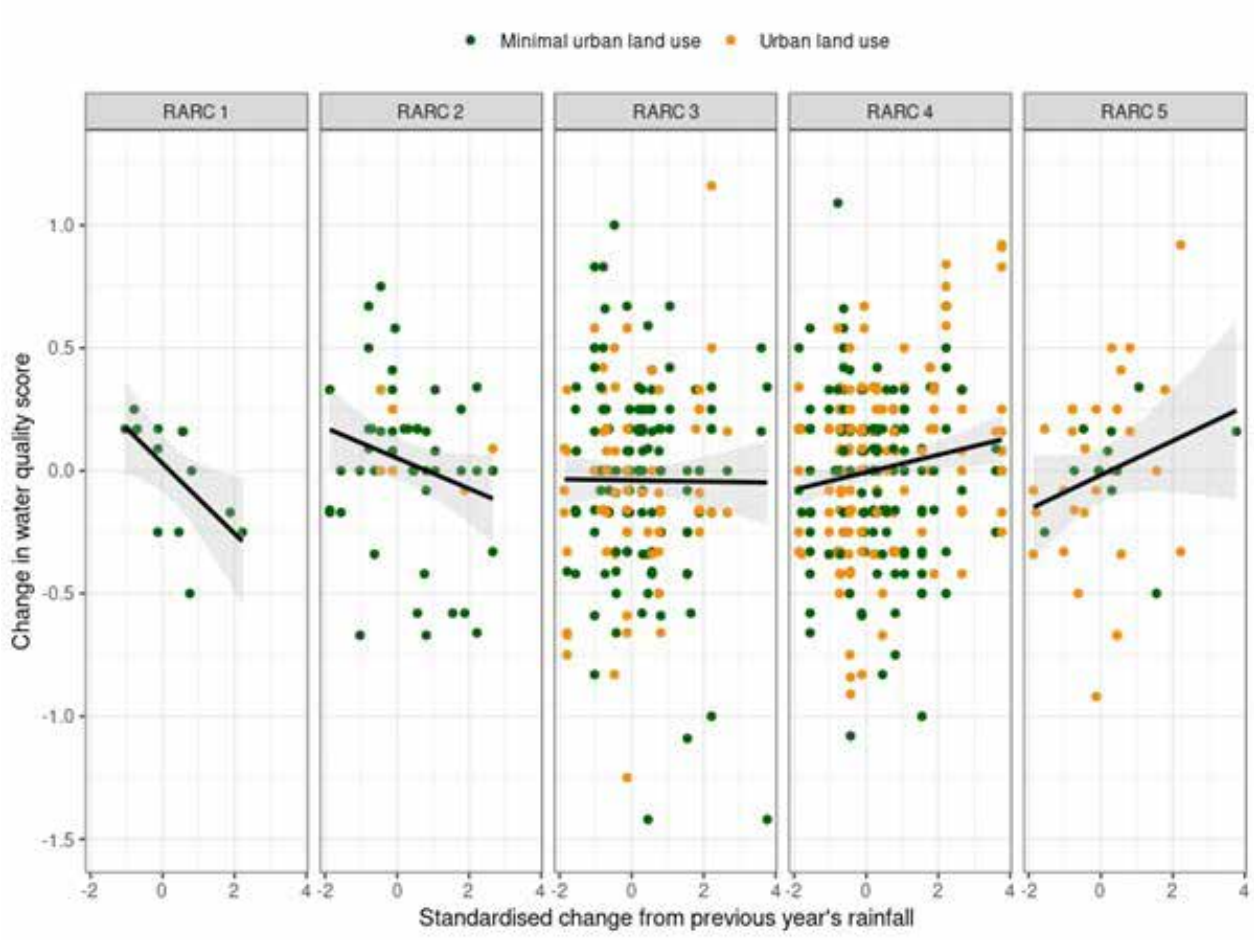


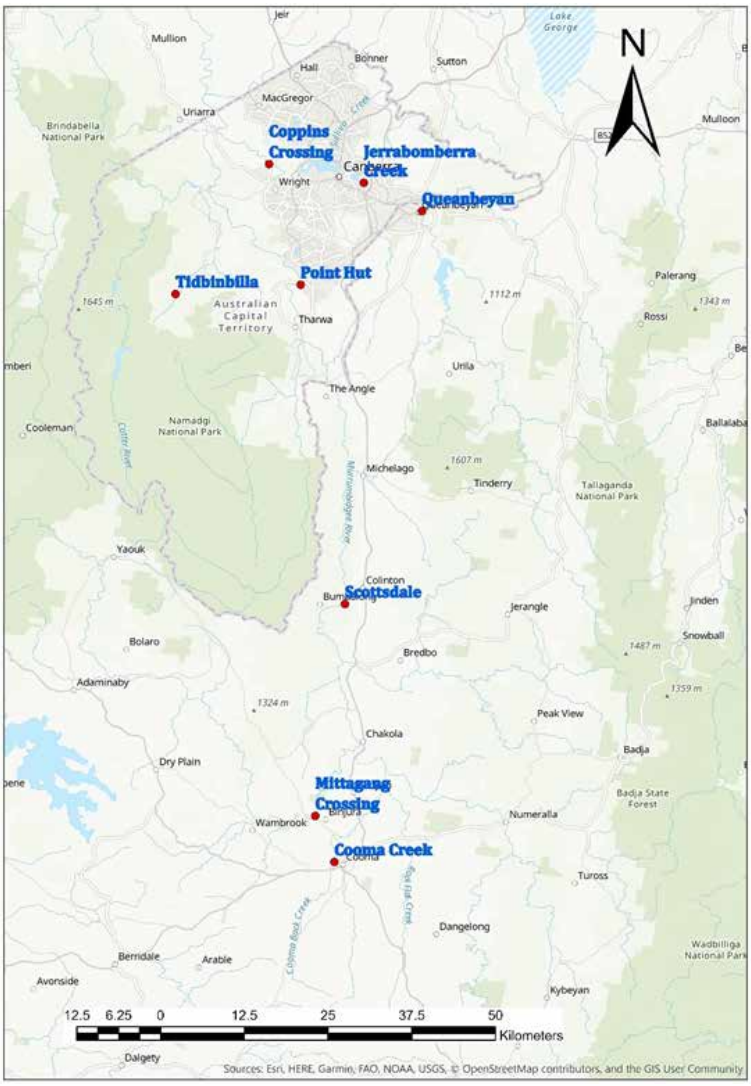
Figure 2. The relationship between change in water quality scores and change in rainfall differs for reaches with different riparian condition (RARC) scores. Each dot represents an individual reach in a particular year. Black lines indicate the average relationship between the change in rainfall and change in water quality. Note that a positive change in water quality score (numbers above the 0 line) indicates a decline in water quality (because a larger number is a worse score). When RARC scores are good to excellent (1-2) increasing rainfall has a positive effect on water quality scores (lines slope down to the right). When RARC scores are fair (3) increasing rainfall has little effect on water quality (line is flat). When RARC scores are poor to degraded (4-5) increasing rainfall has a negative effect on water quality (lines slope up to the right). Land use classification is indicated by dot colour, demonstrating that no urban reaches have 'excellent' riparian condition and very few have 'good' riparian condition.

Platypus Month 2022

By Woo O'Reilly, Regional Waterwatch Facilitator

Since Platypus Month began in 2014, it has grown from strength to strength. Only four surveys were conducted that first year; two at dawn on Jerrabomberra Creek and two close by on the Molonglo River Reach. Platypus Month 2022 saw us, for the second time, conduct 34 surveys, split evenly between dawn and dusk, at eight sites across the region. Such an increase in scale and frequency has enabled us to have greater confidence in the data we are collecting and to start to get a better understanding of population trends.

A few surveys were able to be conducted in 2021 but the Covid lockdown ensured we didn't get too far. While we have kept these surveys on record, we won't factor the results into our analysis given the uneven number of surveys across the sites and between years. Because of this, we decided to do a one-off, make-up set of surveys in February 2022 to give our terrific group of volunteers their platypus survey fix. Records show that the peak time to see platypus is in late winter (ie. Platypus Month), when bug numbers are getting low and males are preparing for the breeding season. There is a second spike, however, in February when the young are emerging from their burrows. We will look at these results as part of this report.



Map 1: The eight sites across the ACT region where group platypus surveys are conducted.

February surveys

Annual water quality and riparian vegetation condition (RARC) scores were calculated for each reach following the standard CHIP method (see Appendix II), for every year from 2015 to 2022. Annual rainfall data from 1963 to 2022 was downloaded from the Bureau of Meteorology website and used to calculate the 70-year average annual rainfall. This long-term average was then used to calculate the residual rainfall for each year (the standardized difference from the long-term average; i.e., how much wetter or drier than usual is each year). Land use information for each reach was compiled from reach descriptions in the CHIP report, and reaches were classified as being in areas with some urban land use or areas with minimal urban land use (i.e., those with predominantly conservation and/or rural land uses).

Location	Surveys	Number of Individual Rakali (Water Rat)	Number of Individual Platypus
Molonglo River below Coppins Crossing	2	1	3
Jerrabomberra Creek within Nature Reserve	2	1	2
The Sanctuary, Tidbinbilla Nature Reserve	2	1	8
Queanbeyan River, Queanbeyan	2	2	3
Murrumbidgee River, Point Hut Crossing	2	2	1
Murrumbidgee River, Scottsdale Bush Heritage Reserve	6	1	3
Murrumbidgee River, Mittagang Crossing (Near Cooma)	2	2	2
Cooma Creek, Cooma	2	0	0
Total	**20**	**10**	**22**

Table 1: Number of Rakali and platypus detected during the February 2022 make-up surveys. (in lieu of cancelled surveys in August 2021).

Volunteers sighted 22 individual platypus over eight 'river reach' sites across the ACT region in February. This was a positive result given the number of surveys in February was almost half the usual August survey effort. At both Queanbeyan and Molonglo River, volunteers reported sighting individuals that were noticeably smaller and could have quite possibly been juveniles emerging from the burrows. Cooma Creek was the only site not to detect any platypus during February. Ten Rakali were detected overall (Table 1).

August surveys

A total of 21 individual platypus were detected across the eight sites during Platypus Month 2022. This is ten less than were seen during August 2020. While five of the eight sites experienced the same or similar numbers to 2020, three sites saw noticeable declines. Mittagang Crossing on the Murrumbidgee River near Cooma detected only one platypus, down from four in 2020, and two platypus were detected on the Queanbeyan River, down from five in 2020. The other concerning observation was at Jerrabomberra Creek where no platypus were detected at all (three were detected in 2020). This is the first time this has happened since we started monitoring there during Platypus Month 2014.

Location	Surveys	Number of Individual Rakali (Water Rat)	Number of Individual Platypus
Molonglo River below Coppins Crossing	4	2 (2)	2 (2)
Jerrabomberra Creek within Nature Reserve	4	2 (2)	0 (3)
The Sanctuary, Tidbinbilla Nature Reserve	4	1 (0)	7 (7)
Queanbeyan River, Queanbeyan	4	1 (3)	2 (5)
Murrumbidgee River, Point Hut Crossing	4	1 (2)	4 (4)
Murrumbidgee River, Scottsdale Bush Heritage Reserve	6	2 (0)	4 (5)
Murrumbidgee River, Mittagang Crossing (Near Cooma)	4	0 (0)	1 (4)
Cooma Creek, Cooma	4	1 (0)	1 (1)
Total	**34**	**10 (9)**	**21 (31)**

Table 2: Number of Rakali and platypus detected during Platypus Month 2022 surveys (2020 numbers in brackets).

A platypus at Queanbeyan River during the Platypus Walk, August 2021 (photo: John Martin).

The wet weather caused all sorts of issues with the surveys in Platypus Month 2022. 120mm of rain fell over August which is almost three times the monthly average. Over half of this fell on the 4 and 5 August sending large flushes through many of the sites and seemingly causing issues with detectability and/or disruptions to regular platypus foraging behaviour. The timing of the surveys appeared to play a big part in the detectability of individuals. With heavy rain forecast for 4 August, we moved two of the Point Hut surveys to the preceding days. This appeared to pay off as four individual platypus were detected in the dawn survey on 3 August. Conversely, the first Jerrabomberra Creek survey was conducted the morning after the big rain on the 5th when a significant pulse went through the reserve (over 5,000ML/day compared to the usual baseflow of <10ML/day). As mentioned, not a single platypus was sighted there during August and only one sighting in November of two individuals has been reported since. Two individuals were detected on the Queanbeyan River on the 2 August and then, following the high flows, no platypus were detected in the next two surveys. Interestingly, many locals taking their morning walks helpfully informed us that they hadn't seen any since the big flows on the 4/5th and 'it usually takes two weeks before you see them again'. Sure enough, we detected two platypus again just over two weeks later at our final survey for the month.

Figure 1 shows surveys conducted at three sites (Point Hut Crossing, Jerrabomberra Creek and the Queanbeyan River) over the past three years, with the number of individual platypus detected and the flow from nearby gauges. While 2019 was a dry year and numbers were down across the board, numbers improved in 2020 as heavy rain didn't disrupt surveys with high flows to the same degree as 2022. This was mainly due to the landscape still soaking up much of the rain (or filling up dams in the case of Googong, on the Queanbeyan River). One exception is Point Hut in 2020 where you can see high flows coincided with two surveys where zero platypus were detected.

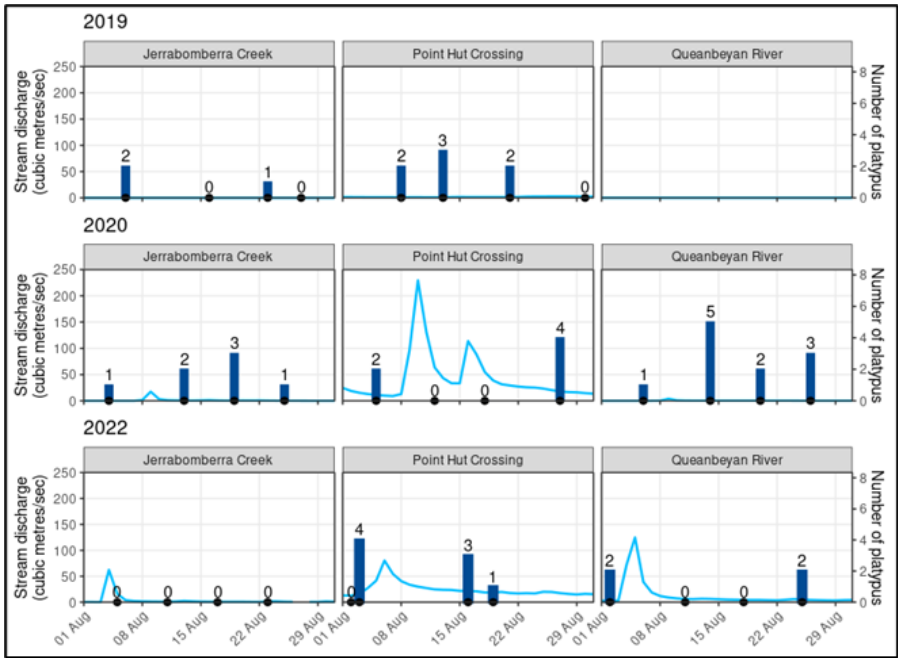


Figure 1: Sightings at three Platypus Month survey sites vs flow over three years. Dots represent surveys

So it appears that high flows may be causing issues with the detectability and/or creating disruptions to regular platypus foraging behaviour. The argument of detectability isn't supported at Jerrabomberra Creek or Queanbeyan River as flows went back to normal levels relatively quickly and yet no platypus were sighted for at least two more surveys, if at all. Having spoken with experts about this, no one is sure what is happening to platypus during these high flow events. They are certainly capable of handling high river levels, having been observed negotiating them with apparent ease. There is also no evidence to support the theory that they are staying in their burrows for an extended period following high flows. The consensus seems to be that they simply spread out further to forage with the increased available habitat. In most cases, they appear to return to normal foraging behaviours after a couple of weeks but, alas, this does not currently appear to be the case in Jerrabomberra Creek. We will keep observing this site with interest and ask people to add any sightings from there to the Platy and Ratty Portal.

The persistent flows have continued to have a positive effect of the condition of our rivers, with the Waterwatch Catchment Health Indicator (CHIP) scores indicating an improvement particularly in our larger river systems. That said, the ash and sediment from the 2019/20 fires is still evident covering the rocks and smothering waterbug habitat and it continues to be remobilised in the water column after significant flows. Staff from Scottsdale Bush Heritage reserve, which was directly impacted by the fires, believe that the platypus population has not been as prevalent since the fires. Ongoing monitoring of this population will be important to determine how they have weathered the impacts. The Scottsdale volunteers were also treated to a very different climatic event when they conducted a survey in the snow in late August (see picture following page)! This occurred during their most successful August survey with four individuals observed! Two Rakali were also observed at Scottsdale which was a pleasing result after not detecting any in 2020.

Mark Recapture surveys

Waterwatch are continuing to work towards strengthening the methods for collecting platypus data so that it can be used to better gauge the status of platypus populations in the ACT region. As part of this, we worked with ecologists from the University of Canberra in 2022 to undertake some mark and recapture surveys. Mark and recapture is a method used to estimate the size of a population when it is impractical to count every individual. The ecologists capture the platypus in fyke nets and then insert an identification tag in them so they can be scanned for an individual code if caught again. The platypus are also sexed and the amount of fat in their tail is measured as a way of gauging their condition.

Unfortunately, the high river flows caused issues with this method too! Only three individuals were captured from nine surveys over three sites. This illustrates that the different methods for collecting data on platypus can all have their limitations and having a mixture of approaches is the best way to gain an understanding of a population. Perhaps we will look at doing this study again once the La Nina has passed.

Location	Platypus Month Surveys	# Individual Platypus (PM)	Mark Recapture Surveys	# Individual Platypus (MR)
Molonglo River below Coppins Crossing	4	2	3	1
Murrumbidgee River, Point Hut Crossing	4	4	3	2
Murrumbidgee River, Scottsdale Bush Heritage Reserve	6	4	3	0
Total	14	10	9	3

Table 3: Number of individual platypus detected in Platypus Month surveys at three sites vs number of platypus captured using fyke nets.

Platypus surveys are not for the faint-hearted! Volunteers at Scottsdale Bush Heritage Reserve, August 2022 (photo: Phil Palmer).

Platypus near Butters Bridge on the Molonglo River during the February surveys (photo: Tom Tyrell).

If you are keen to do more platypus data collecting between now and next August, we still have sites available that you can adopt to conduct your own surveys all year round. These can be located on the Australian Platypus Conservancy's (APC) Australian Platypus Monitoring Network page. The sites overlap with our survey areas and are aimed at gaining a better understanding of platypus numbers over the course of the year (ie. beyond Platypus Month). This suits people who would regularly visit these areas and can look for platypus there preferably once or twice a week (can be less frequent) for around ten minutes at a time. The more people signing up to a site the better, as this will increase the number of data points for that site and improve confidence in the data. I urge you to get in touch with us if you think you may be interested and we're happy to talk through what is involved. Go to 'View Findings' on the APMN homepage to see the sites and contact Waterwatch or Geoff Williams (APC).

Thanks again to staff at Scottsdale Bush Heritage Reserve and at Tidbinbilla Nature Reserve who collaborated with Waterwatch to conduct 10 of the 34 group surveys this August (and eight in February). This adds valuable data to the mix that Waterwatch would not otherwise have the capacity to collect.

The Platypus Month surveys are conducted on Ngunnawal and Ngarigo country and Waterwatch acknowledge the continued connection that the traditional owners have to these lands.

And finally, thank you to the volunteers for your support and interest. Know that Waterwatch will continue to work hard to raise awareness and increase our understanding of platypus (and Rakali) in the region. We couldn't do it without you.

Frogwatch 2022 Highlights

By Anke Maria Hoefer, Frogwatch Coordinator

The ACT and Region FrogWatch Program (FrogWatch) is run by the Ginninderra Catchment Group. FrogWatch has been engaging volunteers since 2002 to monitor, restore and protect local frog habitat, and to raise awareness and educate. The program covers the ACT and its surrounding NSW region from Cooma in the south to Gundaroo in the north and from the Cotter River in the west to Captains Flat in the east. Funding for the FrogWatch Program is provided by the ACT Government and Icon Water.

The first half of 2022 was busy with finalising the Landcare led Bushfire Recovery Project, monitoring frog populations in bushfire affected areas in the southern ACT. The ongoing wet conditions made road access very sketchy and most sites were only accessible by foot or bike.

Extreme survey conditions at day and night for Keyama-Mio Hoefer-Dunne, Naas Fire Trail

Mid-winter is always a wonderful time to tune into our local frogs. Walk & Talk sessions in West Belconnen and the Inner North taught partakers how to identify the calls of our winter-breeding frogs, *Crinia signifera* and *Litoria verreauxii,* while sipping on hot chocolate and watching the stars. A range of school education sessions taught learners of all ages about the wonderful world of frogs and their important role in our local environment.

August is Platypus Month, and for the third year, FrogWatch assisted with running the dusk and dawn surveys below Coppins Crossing on the Molonglo River. Volunteers became citizen scientists as they gave their full attention to the mighty *Ornithorhynchus anatinus*. Hooked by the fun experience many signed up to become a FrogWatcher as well! Once a citizen scientist, always a citizen scientist!

Frogs for Wellbeing

Frog Lessons for Wellbeing offered four nature-based adventures after dark throughout September to relax and recharge in a truly ribbit-ing way. The booked-out series was co-hosted with the Landcare ACT's Wellbeing through Nature program, headed by the glorious Sally Holliday. Froggy Facts After Dark for bright young things (Gungahlin), Frogs Up Late for grown-ups (Hackett), and Froggy Fun After Dark for families (Farrer, Ginninderry) were so popular that they will be repeated in 2023. Participants of the Hackett event ear-witnessed the first record of a Striped marsh frog, *Limnodynastes peronii* for the Mt Majura dam.

Why did the frog cross the road?? Its cousin toad it.

Of course, the annual FrogCensus each October is the most important event in the frog year. After many years of practise, it is running like a well-oiled machine and almost 100% of all sites were monitored during the 2022 FrogTober. More details in the summary below.

Mount Painter Bottom Dam, Photo: Sarah Hnatiuk

Tadpole Kits

From mid-October onwards it was frogs at night and tadpoles all day. During Term 4 of the 2022 school year over 100 classes at 58 schools took part in the annual Tadpole Kits for Schools Program, funded by Icon Water. The wet and cooler weather and the lack of sunshine caused slower growth rates for the tadpoles. Many teachers rose to the challenge and used heat mats or lamps, tank heaters and even hot water bottles to keep the taddies warm and cruising along into adulthood. At the end of Term 4 many fat and juicy tadpoles in various stages of development and 33 beautiful froglets could be released at the spawn collection site.

A metamorphosing Striped march frog *Limnodynastes tasmaniensis* in the Orroral Valley

Naas Creek at Boboyan Road Crossing, Namadgi National Park

FrogCensus 2022

Of the 227 active FrogWatch sites, 216 were monitored between one and seven times during October 2022. The average number of visits per site was 2.12; only seven sites were frog-less.

A total of 457 survey reports were submitted, resulting in 1640 frog sightings.

Ten frog species were detected: Plains froglet *Crinia parinsignifera*, Common eastern froglet *C.signifera*, Eastern banjo frog *Limnodynastes dumerilii,* Striped marsh Frog *Limnodynastes peronii*, Spotted grass frog *Limnodynastes tasmaniensis*, Broad-palmed rocket frog *Litoria latopalmata*, Stony creek frog *Litoria lesueuri*, Emerald-spotted tree frog *Litoria peronii*, Whistling tree frog *Litoria verreauxii* and the Smooth toadlet *Uperoleia laevigata*.

Frogspawn

***Litoria verreauxii* juvenile is contemplating its biggest meal ever**

Litoria latopalmata and *Litoria lesueuri* were only detected at three and one sites, respectively. All other species, which are more commonly encountered during the annual FrogCensus had either their highest or second highest ever detection rate in any FrogCensus since it began in 2002.

Species who had their highest detection rate: *Crinia parinsignifera*, *C.signifera*, *Limnodynastes peronii*,*L imnodynastes tasmaniensis*, *Litoria peronii*, and *Litoria verreauxii*.

Species who had their second highest detection rate: *Limnodynastes dumerilii*, *Uperoleia laevigata*.

As in all previous years, the three most frequently detected species were C*rinia signifera, Crinia parinsignifera* and *Limnodynastes tasmaniensis.*

The high species richness in 2022 was also reflected in the highest ever recorded average number of species per survey (3.51) and of species per site (4.29). The highest site diversity was eight species, found at three sites; Mt Majura Dam, Hackett, Lookout Dam, Holt and Strathnairn Main Pond, Ginninderry.

Find out more

For more information about FrogWatch, please refer to our online resource page. You can find out more the FrogWatch objectives as well as the materials and methods used for data collection https://ginninderralandcare.org.au/FrogWatch/

The Canberra Nature Map provides outstanding database support to the FrogWatch program. Find all the local FrogWatch data at: https://FrogWatch-act.naturemapr.org/

Volunteer list

Cooma

Lisa Baier
Lindsay Barrett
Paul Bateman
Alistair Bestow
Ashley Bolton
Rita Brademann
Raen Brademanne
Mick Castles
Deb Collins
Scott Conroy
Annie Didcott
Sarah Essex
Alison Fleming and Brendan Hodgson
Toni Frecker
Dave Harkins
Julee Harden
Anne Henkel
Tina Hessey
Kellie Holt
Jan Hopkins
Louise and Robert Jenkins
Mark and Melinda Kent
Matthew Kent
Maria Linkenbagh
Mike Mannile
Kerryn Milligan and Phil Irons
Leonie McNamara
Mario Russo
Sharon Schulz
Tim Scrace
Mark Shubert
Belinda Sierzchula and Hamish Brown
Daniel Smusko
Edel and Erich Stephan
Tom Tyrrell
Pam Vipond
Penny Voss
Sandra Warn
Jim Wharton
Deb Willocks
Gaylia Young
Mary Ziesack

Molonglo

Andrea Wilson
Angela Braniff
Anna van Dugteren
Annabel Boyer
Aria Carrol
Bridie Noble
Claire Friend
Colleen McMahon
Cooper Pearson
David Bromhead
Deb Shaw
Des Cannon
Dylan Castles
Dylan Robb
Elyssa Castles
Emmerson Bryant
Fraser Argue
Gail Neumann
Glenn McMahon
Grant Battersby
Heather Wrathall
Janelle Friend
John Bissett
John Hyam
John Moore
Joselhin Medina
Jyotirao Wankhede
Kerry Smith
Louise Amos
Luna Adamson
Lyn Grigg
Maree Latimer
Michael Burton
Michael Moore
Mike Sim
Miranda Gardner
Morgan McClure
Nick Loades
Pablo Ernesto Duran Avila
Peter Abbott
Peter Robertson
Peter Watson
Philippa Russell Brown
Rosanna Shamshudin
Ross Taylor
River Adamson
Sage Adamson
Sandy Lloyd
Sarah Essex
Shelley Owen
Sue Gibson
Terry Dixon
Terry Moore
Tony Patis
Wendy and Steve Hodgman
Sarah Essex
Shelley Owen
Sue Gibson
Terry Moore
Grant Battersby

Yass

Richard Bland
Kate Wilson
Jeremy Wilson
Fiona Hamer
Rebecca Widdows
Carol Boughton
Clive Boughton
Paul Churcher
Iain Fyfe
Hannah Edwards
Greg Mader
Shaun Young
Tyson Powell
Rachel Eland
Bridie Noble

Southern ACT

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Anthony Cory
Bonnie Scott
Cristy Froehlich
David Cahill
Dorothy Brown
Holly Lind
Jan Koehler & John Corcoran
Jeni Cumberland
Kate Bell
Mark Anderson & Barry Young
Peter Brown
Richard Bland
Rojee Byanju
Ross Knee
Samantha Burn
Sarah Lindsay
Scott Powers
Sharae Hurley
Sijia Ding
Tony Greenwell & Elissa Dickson
Vera Kurz
ACT Home School Association
ACT Parks & Conservation Service Rangers (Tim Wells, Sally Hatton, J0ames Parker & Mark Elford)
Brindabella Venturers (ACT Scouts)
Caroline Chisholm High School
Conder Wetlands Waterwatch group
Cooleman Ridge Parkcare group
Friends of Tidbinbilla Parkcare group
Gudgenby Bush Regenerators Parkcare group(Martin Chalk, Michaela Popham & Samantha Pavetich)
Icon Water (Kate Rhook)
Paddy's River Waterwatch group (Maree Blume & Jill Smith)
Parkcarers of Southern Murrumbidgee(P.O.S.M) (Deb Kellock)
'Sands' Waterwatch group (Wendy Rainbird & Anne l'Ons)
Tidbinbilla Sanctuary Visitor Assist Program
Uriarra Parkcare group (Barbara Mackin)
Weston Creek, Mt Taylor and 'Mulga' Joey Scout group

Ginninderra

Lesley Harland
John FitzGerald
Gregg Berry
Johanna Wallner
Samantha Burn
Julia Boyd
Luke Wensing
Jim Grenfell
David Fitzsimmons
Mike Bassanelli
Bruce Cowell
Fleur Leary
Ana Maria Londono
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Tashi Wangdi
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Shane Davie
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Trevor Harvey
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Ross Pettersson
Sally Young
Hugh Coppell
Michelle Mclean
Ange Callis
Tyson Powell
Rachel Eland
Bridie Noble

Glossary

Baseline monitoring: The collection of data prior to a planned intervention/project

Confluence: The intersection of two waterways

Cyanobacteria: Photosynthesizing bacteria often responsible for blue-green algae blooms

Data deficient: Being either unsampled or having insufficient information to provide a confident assessment

Dissolved oxygen: The amount of oxygen present within water, either presented as an absolute amount (mg/L) or as a percentage of the total oxygen saturation at a given temperature

Eastern gambusia: A small invasive pest fish introduced from north America also known as Mosquito fish

Electrical conductivity: A measurement of the total combined salts/minerals in water and used as a proxy for salinity

Ephemeral: Contains water intermittently, as opposed to permanent

Erosion: The loss of soil from the land into waterways

Eutrophication: The rapid blooming of algae and cyanobacteria in nutrient-rich water, which can lead to depletion of dissolved oxygen

Fish kill: A natural or artificially induced mass die-off of fish occurring in a small space of time, often related to rapid depletion of dissolved oxygen

Flashy: A term used to describe the temporal response of river discharge following intense rain

Fragmented: Areas of habitat that have become disconnected due to habitat change

Frost hollow: An area of land that is subject to severe frosts. Often occurs near waterways

Galaxias: A small species of native freshwater fish

Gorge: A narrow, steep-sided, often rocky area immediately adjacent to a waterway

Groundwater: Water that is sourced from deep within the soil

Hydrograph: The relationship between river discharge and time

Leachate: Liquid effluent containing harmful substances

Macrophytes: Aquatic plants

Nitrate: A naturally occurring form of Nitrogen. High levels can indicate excessive nutrient inputs into waterways

pH: A measure of the acidity or basicity (alkalinity) of a solution

Phosphorus: A naturally occurring element essential to life. High levels are often implicated in algal blooms in waterways. Measured as Orthophosphate in the CHIP

Rakali: Indigenous name for the native Water-rat

Reach: A length of waterway defined by hydrological, environmental, land use and social attributes for the purpose of reporting on ecosystem health

Riparian: The zone immediately adjacent to a waterway, which both directly receives and contributes to the aquatic ecosystem

Runoff: Water that flows into a waterway after rain

Sand slug: A large intrusion of sand within a river channel

Sediment: Soil that has become washed into a waterway

Stormwater: Water that flows into a waterway after rain from through the urban stormwater system

Stressors: Natural and man-made processes that can negatively affect natural ecosystem function

Turbidity: The degree of suspended solids in water that gives it a muddy colour

Willows: an introduced riparian tree species

Abbreviations

ACWA: Actions for Clean Water Plan (an initiative to reduce turbidity in the upper Murrumbidgee)

mg/L: Milligrams per Litre

µS: MicroSiemens

NTU: Nephelometric Turbidity Units

N: Nitrogen

QAQC: Quality Assurance, Quality Control

RARC: Rapid Appraisal of Riparian Condition

TSR: Travelling Stock Reserve

UMDR: Upper Murrumbidgee Demonstration Reach

Appendix I

Cooma region CHIP scores by parameter

Reach	pH	Turbidity	TP	NO3	EC	DOSat	WQscore	WBscore	RARCscore	CHIPscore	Letter
BAD1	2	1	2	1	1	5	2	1	2.5	1.83	A-
BAD2	1	1	1.5	1	1	3	1.42	1	3	1.81	A-
BRD1	1	1	1	1	2	3	1.5	1.5	3	2	B+
BRD2	1	1	2	1	3	1.5	1.58	3.5	4	3.03	C+
CMM1	2	1	1	1	1	2	1.33	1	4	2.11	B+
CMM2	1	1	1	1	1	1	1	2	4	2.33	B+
CMM3	1	1	2	1	1	1	1.17	1	3	1.72	A-
CMM4	1	1	1	1	1	1	1	3.5	4	2.83	B-
CMM5	1	1	2	2	2	1	1.5	5	4	3.5	C
CMM6	1	2	2	1	3	3	2	2	3	2.33	B+
COB1	2	2	5	2	5	5	3.5	3.5	4	3.67	C
COO1	2	3	4	5	5	3.5	3.75	3	4	3.58	C
COO2	2	3	5	5	5	2.5	3.75	3.5	4.5	3.92	C-
COO3	2	1	5	2	5	3	3	4	4.5	3.83	C-
GUD1	1	1	1	1	5	4	2.17	3	4	3.06	C+
KYB1	1	1	2	1	2	2	1.5	3	4	2.83	B-
MIC1	1	1	2	1	4	4	2.17	2	4	2.72	B-
NUM1	1	1	1	1	3	1	1.33	2.5	4	2.61	B
NUM2	1	1	1	1	2.5	3	1.58	1.5	3	2.03	B+
NUM3	1	1	1	1	2	2	1.33	2	3	2.11	B+
NUM4	1	1	2	1	4	2	1.83	3	3.5	2.78	B-
ROC1	2	1	3	1	5	1	2.17	4	5	3.72	C-
STR1	1	1	2	1	2	1	1.33	3	4	2.78	B-
	Excellent (A)		Good (B)		Fair (C)		Poor (D)		Degraded (E)		

Molonglo region CHIP scores by parameter

Reach	pH	Turbidity	TP	NO3	EC	DOSat	WQscore	WBscore	RARCscore	CHIPscore	Letter
BUR1	1	1	1	1	4	4	2	2	3.5	2.5	B
DIC1	2	2.5	2	1.5	4	3.5	2.58	4	3	3.19	C+
GGG1	1	1	2	4	5	3.5	2.75	3	2	2.58	B
JER1	1	1	1	2	4	4	2.17	2.5	3	2.56	B
JER2	1	3	2	1	4	5	2.67	3	4	3.22	C+
LYN1	2	2.5	2	2	2.5	5	2.67	3	4	3.22	C+
MOL1	1	1	1	1	1	1.5	1.08	2	4	2.36	B
MOL2	1	1	2	2	2	4	2	1	1	1.33	A+
MOL3	1	1.5	2	1	3.5	5	2.33	2.5	4	2.94	B-
MOL4	1	1	2	1	3	3	1.83	2	3	2.28	B+
MOL5	1	3	2	2	3	3	2.33	3	4	3.11	C+
MOL6	1	2	2	2	3	2	2	2.5	3	2.5	B
MOL7	1	1.5	2	5	4	1.5	2.5	2	3	2.5	B
PRI1	1	1	1	2	4	5	2.33	2.5	4.5	3.11	C+
QUE1	1	1	1	1	1	4	1.5	3	3	2.5	B
QUE2	1	1	1	1	2	1	1.17	2	3	2.06	B+
QUE3	1	1	2	1	3	3	1.83	2.5	4	2.78	B-
SUL1	2	1	2	2	4.5	5	2.75	3	4	3.25	C+
SUL3	1	1	2	2	4	5	2.5	3	4	3.17	C+
SUW1	1.5	1.5	2	2	3	5	2.5	3	3	2.83	B-
SUW2	1	3	2	2	2	5	2.5	3	3	2.83	B-
WAT1	1.5	1	1.5	1.5	2.5	5	2.17	5	4	3.72	C-
WES1	1	1	4	4	4	5	3.17	3	4	3.39	C
WOO1	1	1	1	1	5	5	2.33	3	4	3.11	C+
YAN1	1	1	1.5	1	2	3	1.58	2.5	2.5	2.19	B+
YAR1	1	2	2	1	4	5	2.5	3	4	3.17	C+
	Excellent (A)		Good (B)		Fair (C)		Poor (D)		Degraded (E)		

Ginninderra region CHIP scores by parameter

Reach	pH	Turbidity	TP	NO3	EC	DOSat	WQscore	WBscore	RARCscore	CHIPscore	Letter
CMM11	1	1	2	3	2	2	1.83	5	4	3.61	C
GDC1	1	2	1	1	4	3	2	3	4	3	C+
GIN1	1	2	1	1	4	3	2	3	4	3	C+
GIN2	1	1	1	2	4	2	1.83	3	4	2.94	B-
GIN3	1	1	1	2	4	4	2.17	4	4	3.39	C
GIN4	1	2.5	2	2	4	5	2.75	3	4	3.25	C+
GIN5	1	1	2	4	4	2.5	2.42	5	4.5	3.97	C-
GIN6	1	1	1.5	3	4	2	2.08	5	3	3.36	C
GOO1	1	1	3	2	5	5	2.83	2.5	4.5	3.28	C+
GUN1	2	1	2	2	5	3	2.5	3	4	3.17	C+
GUN2	1	1	2	2	4	5	2.5	3	4	3.17	C+
KIP1	1	2.5	4	5	5	3.5	3.5	3	4	3.5	C
MCW1	1	2	2	2	4	5	2.67	3	4	3.22	C+
MFL1	2	3	2	1	1	5	2.33	4	3.5	3.28	C+
YER1	1	1	1	2	4	3	2	3	4	3	C+

Excellent (A)	Good (B)	Fair (C)	Poor (D)	Degraded (E)

Southern region CHIP scores by parameter

Reach	pH	Turbidity	TP	NO3	EC	DOSat	WQscore	WBscore	RARCscore	CHIPscore	Letter
BOG1	2	1	2	1	1	2	1.5	1.5	3	2	B+
CGG1	1	1	2	1	1	1	1.17	1	4	2.06	B+
CMM10	1	2	1	1	2	3.5	1.75	2	4	2.58	B
CMM7	1	1	2	1	3	3	1.83	1	3.5	2.11	B+
CMM8	1	1	1	1	2	4	1.67	2	3.5	2.39	B
CMM9	1	1	2	1	2	1	1.33	3	3	2.44	B
COT1	3	1	1	2	1	4	2	3	3	2.67	B
COT2	3	1	1	2	1	1	1.5	1	2	1.5	A
COT3	1	1	1	1	1	1.5	1.08	3	3	2.36	B
GIB1	1	1	1	1	1	3	1.33	2	1	1.44	A
GUI1	1	1	2	2	3	4	2.17	2	4	2.72	B-
HOS1	1	1	2	2	1	2	1.5	1.5	3	2	B+
ISA1	1	1	2	5	4	3	2.67	3	4	3.22	C+
MMB1	1	2	2.5	1	4	5	2.58	3	3	2.86	B-
MPG1	1	3	1.5	2	3	5	2.58	3	4	3.19	C+
MSP1	1	1	1	2	4	2	1.83	4	3.5	3.11	C+
NAA1	1	1	1	1	2	1	1.17	3	2	2.06	B+
NAA2	1	1	3	1	2	2	1.67	1.5	3.5	2.22	B+
ORR1	1	1	1	2	1	5	1.83	1	1	1.28	A+
PAD1	1	3	1	1	1	3	1.67	2	4	2.56	B
RAN1	3	3	3	1	2	5	2.83	3	4	3.28	C+
TID1	2	1	1	1	1	3	1.5	1	2	1.5	A
TLT1	2	2.5	2	5	4	3	3.08	3	4.5	3.53	C
TLT2	1	3	2	4	3	4	2.83	3	4	3.28	C+
TUG1	2	1	2	1	3	3	2	1	4	2.33	B+
TUG2	2	1	2	5	4	3	2.83	5	5	4.28	D+
TUG3	1	2	3	2	3	3	2.33	4	3	3.11	C+

Excellent (A)	Good (B)	Fair (C)	Poor (D)	Degraded (E)

Yass region CHIP scores by parameter

Reach	pH	Turbidity	TP	NO3	EC	DOSat	WQscore	WBscore	RARCscore	CHIPscore	Letter
CMM12	1	1	1	5	3	1	2	4.5	3.5	3.33	C+
CMM13	1	1	1	2	3	2	1.67	5	3	3.22	C+
YAS1	1	2	2	1	4	5	2.5	3	4	3.17	C+
YAS2	1	2	2	2	5	5	2.83	2.5	3.5	2.94	B-
YAS3	1	3	2	2	5	2.5	2.58	3	3	2.86	B-
YAS4	1	2	2	4	5	1	2.5	4	3	3.17	C+

Excellent (A)	Good (B)	Fair (C)	Poor (D)	Degraded (E)

Appendix II

CHIP Methodology

Upper Murrumbidgee Waterwatch (Waterwatch) produces an annual catchment health report called the Catchment Health Indicator Program (CHIP), based upon the data collected by volunteers throughout the preceding year. This report is a key output of this program, and is used as both a communication tool and to inform management and policy regarding water resource use and protection. Multiple complex calculations are involved in producing the CHIP, and numerous catchment groups around Australia produce similar (albeit slightly different) CHIPs. Specific details regarding these CHIPs are not generally forthcoming and so this document aims to clearly outline the underlying philosophy and methodology regarding the Waterwatch CHIP reports.

Multiple Types of Data

Waterwatch volunteers and coordinators collect data relating to water quality, macroinvertebrate abundance and diversity, and riparian condition. Each of these data sources are 'indices' or 'parameters', which, when combined, form an 'indicator'. Currently, the goal for volunteers is to collect water quality data every month, at every site. Volunteers and coordinators also collect aquatic macroinvertebrate data twice a year, in Spring and Autumn at key sites within each reach, generally near the bottom of each reach (to provide an indication of the entire reach). Finally, Rapid Appraisal of Riparian Condition (RARC; Jansen et al. 2005) assessments are conducted by volunteers and coordinators at each site once every 2 years (biennially). RARCs are conducted at lower frequency, as riparian condition changes at a slower rate than macro-invertebrate assemblages, and water quality. All these parameters are combined into the CHIP. Finally, additional data regarding algae abundance, river flow and height, diversity and frog abundance and Platypus abundance are used to provide context regarding catchment health. These, however, are not formally included in the CHIP calculations (Table 1). More details regarding these additional data sources can be found in the section "Additional Data".

Water Quality Parameters

Currently, volunteers strive to collect water quality data for multiple parameters every month (Table 1). These parameters have been widely established as the best indicators of water quality while being relatively easy to measure and have been discussed in detail elsewhere (eg. Waterwatch Victoria 1999). While there are known (and unknown) site-specific variations in these parameters, it is generally accepted for a majority of these that a specific range of values indicate good catchment health (eg. ANZECC 2000). Deviations away from these ideal values indicate declining health of the waterway. It is this philosophy that underpins the computations of the CHIP, and the grading of catchment health (see Appendix III).

Table 1. Summary of waterway health parameters collected by volunteers and coordinators, that are included in the CHIP.

	Parameter	Frequency	Number of sites
Water Quality	pH	Monthly	All sites
	Electrical Conductivity	Monthly	All sites
	Turbidity	Monthly	All sites
	Phosphorus	Monthly	All sites
	Nitrate	Monthly	All sites
	Dissolved oxygen	Monthly	All sites
	Temperature	Monthly	All sites
Macroinvertebrates	SIGNAL 2.0	Biannual (Spring & Autumn)	Key sites (min 1/reach)
Riparian Condition	RARC	Biennial	All sites

Macroinvertebrates

Aquatic fauna (and flora) are ideal indicators of catchment health, as they are entirely dependent on the waterway for their existence. Aquatic macroinvertebrates differ greatly in their requirements, and their tolerances to changes in their aquatic environment. Numerous programs exist to assess waterway health based upon abundance and diversity of macroinvertebrate assemblages (eg. AUSRIVAS, SIGNAL, ALT) and are similar in many respects. Waterwatch uses SIGNAL 2.0, with macroinvertebrate identification to the order level (not family as with AUSRIVAS). Specific details of the sampling methodology are outlined in the SIGNAL 2.0 user manual (Chessman 2001; Chessman 2003).

The SIGNAL 2.0 score obtained at each site receives an additional calculation to produce a modified stream pollution index based on the diversity of macroinvertebrates found at a site. We have included an additional criteria that examines whether the three key sensitive orders of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) are present, to aid with standardising scoring across the three data sources (Water Quality, Waterbugs and RARC). This number is transformed into an index score (similar to the water quality parameters, above), and the median value of all the sampling periods within the reach (including spring and autumn surveys), before being included in the CHIP (Table 2). Further details are present in Appendix III.

Table 2. Summary of SIGNAL 2.0 scores, and thresholds between the CHIP score categories.

Number of Taxa	SIGNAL Score	EPT Present	EPT Absent
>7	> 5.5	Excellent	Good
>7	≤ 5.5	Good	Fair
≤ 7	> 5.5	Fair	Poor
≤ 7	≤ 5.5	Poor	Degraded

Riparian Condition

The riparian zone along a waterway is integral to waterway health. The riparian zone performs several important functions, including acting as a buffer and filter to incoming runoff, and extracting nutrients from the waterway itself. Currently, RARC assessments are conducted biennially at all sites.

RARC was developed for use along the Murrumbidgee River in open floodplains dominated by a River red gum overstorey. As such, its applicability to the upper Murrumbidgee River catchment, urban environments and non-riverine habitats is questionable. However, it is still likely to be an effective tool for recording changes in riparian composition over time, irrespective of the score. The thresholds applied in the CHIP are as follows (Table 3). These thresholds may be revised in the future, to better reflect the actual distribution of RARC scores present in the upper Murrumbidgee River catchment.

Table 3. Summary of RARC scores, and thresholds between CHIP score categories.

RARC Score	CHIP Parameter
41–50	Excellent = 1
31–40	Good = 2
21–30	Fair = 3
11–20	Poor = 4
0–10	Degraded = 5

Combining Water Quality, Macroinvertebrate and RARC Data

Using the scores calculated for water quality, macroinvertebrates and RARC assessments, these values are averaged for each site. Currently, water quality, macroinvertebrates and RARCs are equally weighted in the CHIP. However, in the event that one of these is missing, a CHIP score is still produced. If two of the three assessments are missing for a reach, no CHIP score is produced.

Data Density

A potential source of bias can arise from insufficient data collection at sites within reaches. In order to overcome some of these issues, a rule has been applied to the water quality data to ensure a minimum amount of data is present, before a CHIP score is produced. Currently, a minimum of 25% of total potential water quality data must be present for a CHIP score to be produced. This is calculated by dividing the total number of sampling events available for analysis in the preceding year, by the number of sites within a reach, multiplied by the number of total sampling events that should have occurred (12). This provides a proportional measure of the amount of sampling that has taken place within a reach in the preceding 12 months. In the event that <25% of data was collected, the water quality data is not included in the computation of a CHIP score.

The CHIP Score

The resulting CHIP score for each reach provides an indication of the overall health of that particular reach. While specific site-level variations (eg. some sites have naturally high electrical conductivity, low pH etc) may receive lower scores, it therefore requires that careful interpretation of these CHIP values be undertaken prior to making inferences of catchment health. In addition, the application of SIGNAL 2.0 in non-flowing aquatic habitats and RARC assessments in heavily urbanised environments may produce unusually low scores. In these instances, comparing within reaches, between years will be more appropriate than comparing between reaches, within years. These considerations must be taken into account when using and interpreting the CHIP. Finally, vitally important context is provided by the Waterwatch coordinators, who know the underlying geology, hydrology, land use and history of the catchments. Their expert knowledge is critical to valid interpretations of the CHIP scores.

References

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Chessman, B. (2003) New sensitivity grades for Australian river macroinvertebrates. *Marine and Freshwater Research* 54: 95-103

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Appendix III

Refining macroinvertebrate scores

Background

As part of the continual process of improving the rigour and transparency behind the calculation of CHIP scores, Waterwatch re-evaluated the process regarding how macroinvertebrate survey data contributes to producing final reach scores.

Throughout the 2013-2014 and 2014-2015 CHIP reports, macroinvertebrate scores have been based upon the divisions defined in the SIGNAL 2.0 manual (Chessman 2003; Table 1).

Table 1. Previous approach to computing CHIP scores based on macroinvertebrate sensitivities and and abundance, as defined by SIGNAL 2.0 (Chessman 2003).

	Number of macroinvertebrate orders	
SIGNAL SCORE	**0 - 7**	**>7**
>5.5	Fair	Excellent
≤ 5.5	Poor	Good

Macroinvertebrate surveys are categorised into 1 of 4 categories based on the number of taxonomic groups (Orders) and the weighted sensitivity of those orders collected (Chessman 2003). For example, where the weighted sensitivity is >5.5 and the number of taxa >7, will result in a CHIP score of *Excellent*. Conversely, a weighted sensitivity of ≤ 5.5 and ≤ 7 taxa would result in a CHIP score of *Poor*.

Unfortunately, this did not fit well with our five category ranking of catchment health. Indeed, under the previous scheme, it would be impossible to score a reach as *Degraded*, as there is no *Degraded* category for macroinvertebrates.

Adjusting the score to 5 levels

To make the adjustment to a 5-level scoring system for macroinvertebrates, Waterwatch incorporated an additional criteria to the computation of the CHIP score for each macroinvertebrate survey (Table 2). This additional criteria examines whether all three EPTs (Ephemeroptera, Plecoptera and Trichoptera) are present. If 2 or less are present (eg. any one or more of these taxonomic groups are missing), then scores are penalised (Table 2).

Table 2. New macroinvertebrate scoring system for the 2015-16 CHIP.

Number of Taxa	SIGNAL Score	EPT Present	EPT Absent
>7	>5.5	Excellent	Good
>7	≤5.5	Good	Fair
≤ 7	>5.5	Fair	Poor
≤ 7	≤ 5.5	Poor	Degraded

Why EPTs?

The "EPTs" (Ephemeroptera, Plecoptera and Trichoptera) are the three orders of highly sensitive waterbugs – the mayflies, stoneflies and caddisflies. These three orders are generally present where both water quality and aquatic habitat are in excellent condition. Indeed, in all surveys undertaken in the upper Murrumbidgee catchment by Waterwatch in the previous two CHIPs, all surveys listed as *Excellent* contained these three orders. Both nationally and internationally, there is a strong focus on the EPTs as they are universally considered to be good indicators of good catchment health (eg. Marchant et al. 1995).

What do these changes mean for the CHIP?

The main effect this change has on the CHIP report is providing greater differentiation between *Good*, *Fair* and *Poor* reaches. Furthermore, is now mathematically plausible to score a reach as *Degraded*. All previous sites scored as *Excellent* are unlikely to change, however reaches scored as *Good*, *Fair* and *Poor* have greater scope to shift downwards, if these three important taxa are missing from their macroinvertebrate surveys.

How does this change the previous CHIP?

By way of examination of these changes on the CHIP result, here we present a comparison of CHIP scores from the 2014–2015 CHIP report, with the old CHIP scores (Table 3).

Table 3. Summary of changes to the reach scores from the 2014-15 CHIP with the update in macroinvertebrate scoring.

SCORE	OLD	NEW
Excellent	4	4
Good	45	34
Fair	36	42
Poor	5	10
Degraded	0	0

In all reports following the 2015-2016 CHIP, Waterwatch has used the new macroinvertebrate scoring methodology.

References

Chessman, B. (2003) New sensitivity grades for Australian river macroinvertebrates. *Marine and Freshwater Research* **54:** 95-103

Marchant, R., Barmuta, LA., and Chessman, B. (1995) Influence of sample quantification and taxonomic resolution on the ordination of macroinvertebrate communities from running waters in Victoria, Australia. *Marine and Freshwater Research* **46:** 501-506.

Appendix IV

Refining water quality thresholds for the CHIP

Background

In developing the 2013–2014 CHIP, a set of thresholds had to be applied to the water quality parameters in order to produce water quality scores. These are summarised in Table 1.

Table 1. Summary of 2013–2014 water quality thresholds for the CHIP report.

Indicator Rating	Excellent - 1	Good - 2	Fair - 3	Poor - 4	Degraded - 5
pH	6.0 – 6.9	5.5 – 5.9 or 7.0 – 7.9	8.0 – 8.5	5 – 5.5 or 8.5 – 8.9	<5 or >9
EC (µS/cm)	<= 65	<= 200	<= 350	<= 400	> 400
Turbidity (NTU)	<= 10	<= 12.5	<= 15	<= 20	> 20
Dissolved oxygen (mg/L)	*(Not included in CHIP)*				
Dissolved oxygen saturation (%)	95 – 105	85 – 95 or 105 – 110	75 – 85	65 – 75 or 115 – 120	< 65 or > 120
Phosphorus (mg/L)	< 0.01	0.01 – 0.02	0.02 – 0.05	0.05 – 0.09	> 0.09
Nitrate (mg/L)	< 1.0	1 – 4.9	5 – 9.9	10 – 15	> 15

These thresholds were based largely on those developed by the Molonglo CHIP report (M-CHIP). The M-CHIP values were developed in 2 parts – an urban and rural scale. The rural-scale values were used for the 2013–2014 CHIP report, with a few minor tweaks (mostly to dissolved oxygen) before being implemented. Unfortunately, there is no clear evidence trail of how these thresholds were developed, and so Waterwatch treated them as based upon expert knowledge.

For the 2014–2015 CHIP report, Waterwatch aimed to develop a new set of thresholds based upon water quality data collected in the ACT region. The key issues in developing these thresholds are outlines below.

Identifying a data set: independence, data quality and reference sites

Numerous sources (ANZECC, ACT Water Regulations, other catchment report cards) promote the development of meaningful thresholds based upon a 'training dataset'. A training dataset is a relevant water quality dataset used to determine thresholds which can be applied to data collected throughout the catchment for the purposes of reporting. The strengths of this approach are that thresholds are locally relevant, are developed in a transparent manner and are updateable and repeatable.

Ideally, an independent dataset would be used to redefine thresholds. This has two major benefits.

Firstly, an independent dataset would not be burdened with any real or perceived data quality issues that volunteer collected data may have. Key issues regarding sampling bias, accuracy and precision of equipment and reporting of data can be eliminated. Secondly, thresholds developed from an independent dataset may be retrospectively applied to all Waterwatch data. The use of Waterwatch data would prevent the application of thresholds to data used to define the thresholds (a problem of circularity).

There are limited sources of data available in the ACT region which may be used to develop thresholds. The most obvious data sources are those collected and maintained by the ACT Government, Icon Water and University of Canberra.

In examining the external water quality data to develop thresholds, a key consideration is the choice of sites with which to use to create new thresholds. Obviously, the choice of sites will have a major impact on the threshold values produced. Sites that are considered to represent 'reference condition' are preferred over all others. Reference condition is defined, for the purposes of the CHIP, as sites that represent minimally impacted areas in the ACT region. Ideally, these sites will exist in minimally impacted agricultural or conservation managed lands, without significant impacts from urban centres or major developments.

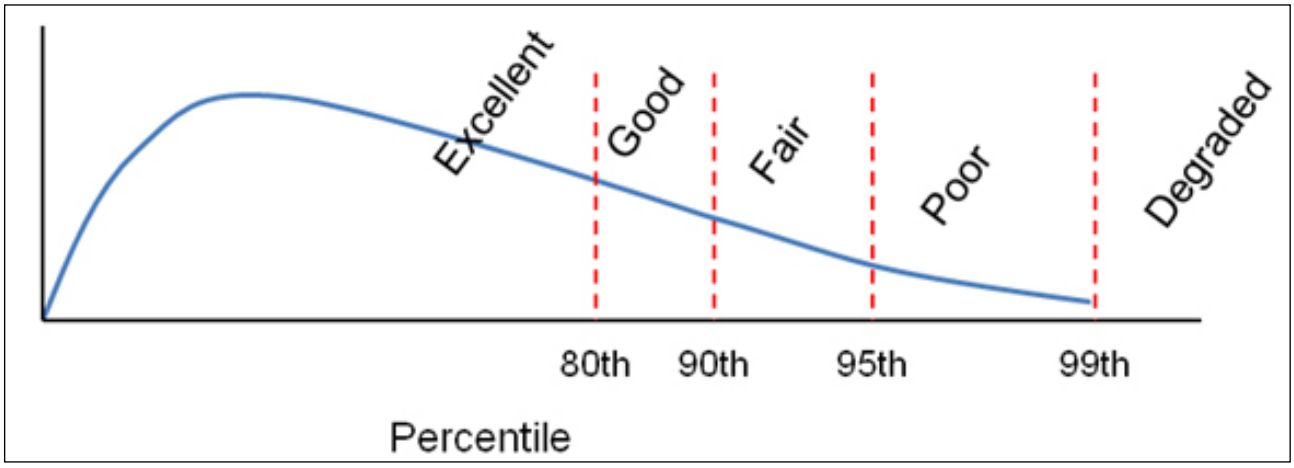
A second key issue is the amount of data available. This is further complicated by the impact that the millennium drought had on reference site condition. For example, data from reference sites of the AUSRIVAS macroinvertebrate monitoring program showed major declines in the relative health of some reference sites during the millennium drought. This is not surprising, but including data that shows negative impacts of drought would influence the discriminatory power that the reference condition approach could provide. These impacts are likely to be present in water quality data that exists from the same time period.

Defining the thresholds

There are numerous ways water quality data could be categorised to produce a score, but Waterwatch have chosen to use percentiles derived from a frequency histogram of water quality data taken from reference sites to define the thresholds for the CHIP.

Our approach is outlined in figure 2. After creating a frequency histogram from reference condition data, the threshold values for each parameter are defined using the 80th (*Excellent*), 90th (*Good*), 95th (*Fair*), 99th (*Poor*) and >99th (*Degraded*) percentile. The implicit assumption is that parameter values that occur in excess of 80% of the time in the reference sites reflect *excellent* quality, with rarer occurring events being of lower quality. Finally, it is assumed that *Degraded* water quality would only be observed <1% of the time in a reference condition site.

Figure 2. Depiction of defining thresholds based upon a frequency distribution of data.



Identification of 'reference sites'

The selection of sites from which to produce thresholds will have a major impact on final scores produced in the CHIP report. Site selection is critical to how scores are interpreted. While arguably the score is irrelevant, and rather the change in any site/reach through time is more important, the reality is that scores will be interpreted directly without appropriate thought to how they were derived.

Preference will be to select sites that exhibit minimal levels of agricultural and urban impacts. Avoiding urban influences should be relatively straightforward, however agriculture is widespread throughout the upper Murrumbidgee catchment, hence obtaining sites without agricultural impacts will be difficult. Furthermore, historical impacts from agriculture, mining and land clearing may still be having pervasive impacts on water quality, which may be hard to identify in the first instance, and may not be readily avoidable, in any case. As such, 'reference condition' must not be interpreted as 'pristine'. Rather, it reflects the condition of minimally impacts sites within the catchment. As such, long-term goals aspiring towards water quality in sites equivalent to that of reference condition is a worthy goal, yet by no means suggests a return to pristine or non-impacted conditions.

There are limited sites in the upper Murrumbidgee River catchment that have long-term data records from which to derive frequency distributions. Data available from Icon water for the upper Cotter River catchment (above, and including Corin Reservoir) and water quality collected from the Goodradigbee River catchment represent the most practical 'reference condition' datasets for the CHIP.

The catchments to the east of the Murrumbidgee River have a different underlying geology compared to the catchments west of the Murrumbidgee River (eg. the Cotter River, and Goodradigbee River.) Likewise, the Ginninderra and Yass catchments may tend to exhibit high electrical conductivity compared to other catchments. With additional data, electrical conductivity thresholds could be developed for the Molonglo, Ginninderra and Yass catchments, provided suitable data from 'reference condition' sites could be found. This is highly unlikely to occur.

Data availability

Icon Water generously provided water quality data for 2 riverine sites upstream of Corin Reservoir, three sites within the upstream-most section of Corin reservoir, and data from 3 sites on the Goodradigbee River, and 3 sites on tributaries of the Goodradigbee River, collected by University of Canberra (Table 2).

Table 2. Summary of sites used to define reference condition for CHIP thresholds.

Site Name	Years of data	Parameters
Cotter Hut	2007-2014	pH, turbidity, EC, DO
Gingera	2003-2015	pH, turbidity, EC, DO
Corin Reservior site 7	1994-2015	TN, TP
Corin Reservior site 8	1993-2015	TN, TP
Kangaroo Ck	2003-2015	TN, TP
Goodradigbee River site 1	2006-2015	pH, Turbidity, EC, TN, TP
Goodradigbee River site 2	2006-2015	pH, Turbidity, EC, TN, TP
Goodradigbee River site 3	2006-2015	pH, Turbidity, EC, TN, TP
Goodradigbee Tributary 1	2006-2015	pH, Turbidity, EC, TN, TP
Goodradigbee Tributary 2	2006-2015	pH, Turbidity, EC, TN, TP
Goodradigbee Tributary 3	2006-2015	pH, Turbidity, EC, TN, TP

Data analysis

Data analysis involved producing frequency histograms of each of the water quality parameters at each site. Firstly, the impact of the millennium drought was explored by comparing histograms for data collected 2010-current, against pre-2010 data. If no observable difference in distributions was present, data was combined. If significant differences were present, only data post-2010 was considered for threshold production.

After identifying non-drought impacted data, sites were combined and examined. If substantial differences in distributions were evident across sites, they were not combined. Conversely, if no major discrepancies were present, data across sites was combined. The exception to this rule was made for electrical conductivity – the upper Cotter River is very low in electrical conductivity, compared to the Goodradigbee catchment. Waterwatch chose to combine data from the Cotter River and Goodradigbee River to produce electrical conductivity thresholds for the CHIP as this will better reflect the apparent naturally higher electrical conductivity readings from other areas in the catchment such as the Molonglo and Ginninderra.

Current thresholds

Table 3 presents the threshold values applied in the current CHIP. Thresholds were developed based upon the 80th (*Excellent*), 90th (*Good*), 95th (*Fair*), 99th (*Poor*) and > 99th (*Degraded*) percentiles, for each parameter. For pH and dissolved oxygen, the 10th and 90th (*Excellent*), 5th and 95th (*Good*), 2.5th and 97.5th (*Fair*), 0.5th and 99.5th (*Poor*) and <0.5th and >99.5th (*Degraded*) percentiles were used to define thresholds. These thresholds were redefined for the 2014-15 CHIP report onwards.

Table 3: Water quality CHIP thresholds.

Parameter	Excellent	Good	Fair	Poor	Degraded
pH	6.6 – 7.8	6.1 – 6.5, 7.9 – 8.0	5.7 – 6.0, 8.1 – 8.2	5.4 – 5.6, 8.3 – 8.6	< 5.4, > 8.6
EC (µS/cm)	≤ 98	99 – 156	157 – 212	213 – 404	> 404
Turbidity (NTU)	≤ 10	11 – 16	17 – 36	37 – 90	> 90
DO (mg/L)	*(Not included in CHIP)*				
DO Sat. (%)	88 – 99	84 – 87, 100	81 – 83, 101 – 106	78 – 80, 107 – 115	< 78, > 115
Phosphorus (mg/L)	< 0.02	0.02 – 0.03	0.04 – 0.05	0.06 – 0.08	> 0.08
Nitrate (mg/L)	< 1.0	1.0 – 1.3	1.4 – 1.7	1.8 – 2.6	> 2.6

Going forward: interpreting the CHIP

Interpreting CHIP scores must explicitly consider how the scores were derived. The data used to derive the water quality thresholds come from water quality monitoring sites in the upper Cotter River catchment and the Goodradigbee River catchment.

As such, all WQ CHIP scores are to be considered in relation to the 'reference condition'.

Waterwatch CHIP Launch, 8:00am 22 March 2023, Dickson Wetlands, Dickson

Still being updated

NUMBER	NAME	ASSOCIATION
	Waterwatch Volunteers	
	Personal information	Southern ACT
		Southern ACT
		Molonglo
		Molonglo
		Molonglo
		Ginninderra
7		
8		
9		
10		
	Waterwatch staff	
	Personal information	Molonglo Waterwatch
		Ginninderra Waterwatch
		Southern ACT Waterwatch
		Cooma Waterwatch
		Frogwatch Coordinator
		Citizen Science Analyst
	Other Officials	
16	Sophie Lewis	OCSE
	Personal information	CEO, Landcare ACT
		Icon Water
		Ginninderra Catchment Group
		Molonglo Conservation Group
		Molonglo Conservation Group
23		
	EPSDD, ACT Government	
24	Bren Burkevics	Director, Environment Division
25	Frank Garofalow	ACTNRM
26	Danswell Starrs	Healthy Waterways
27	Ralph Ogden	Director, Healthy Waterways
28	Chris Glennon	Senior Director - Resilient Landscapes Branch
29	Emma Humphreys	Senior Director – Office of Water
30	Tom Nilsen	Director, Office of Water
31	Lindsey File	Office of Water

- Plus Minister Rattenbury and company
- Plus possible media

CONTACT: Woo O’Reilly (Regional Waterwatch Facilitator) – Personal Information