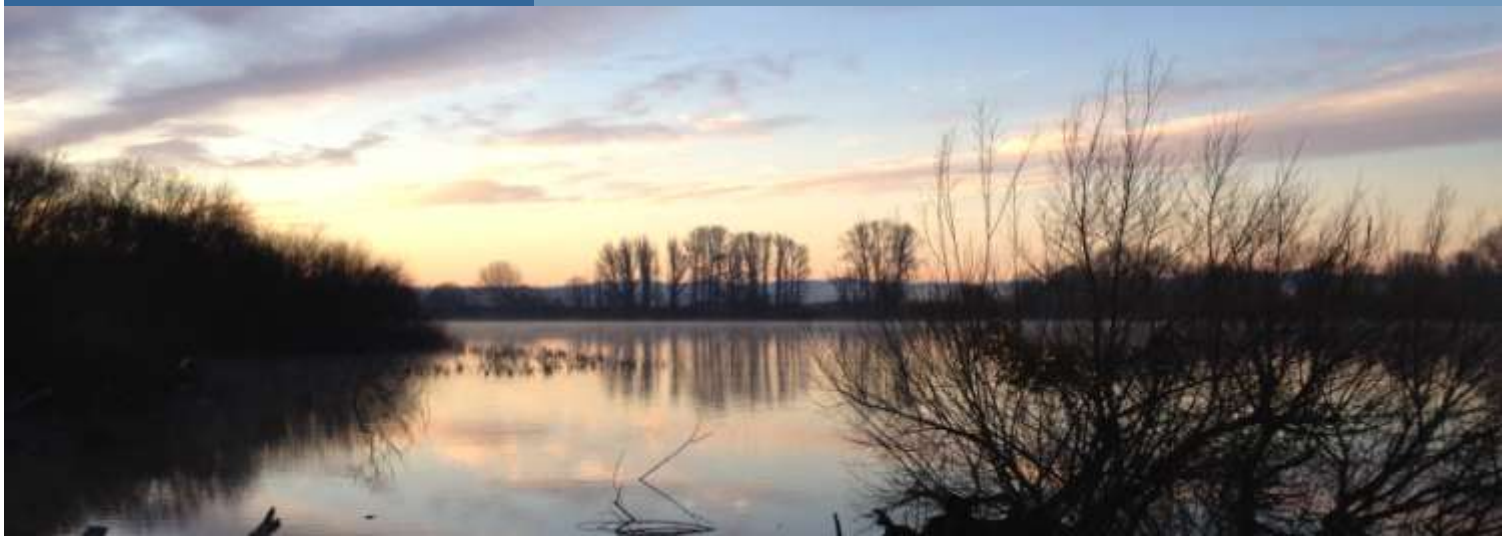
WATERWATCH
Upper Murrumbidgee

CHIP

Catchment Health Indicator Program

Report Card 2013/14



Supported by:

ACT Government
Environment and Planning

ACTEW WATER

In partnership with:

Molonglo Catchment Group

Southern ACT Catchment Group Inc

Ginninderra Catchment Group

This report was written using data collected by over 160 Waterwatch volunteers. Many thanks to them.

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

Infrastructure support for upper Murrumbidgee Waterwatch data provided by the Atlas of Living Australia:
https://root.ala.org.au/bdrs-core/umww/home.htm

EXECUTIVE SUMMARY

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 near Yass, an area of more than 13,000km^2.

Two primary functions of the Waterwatch program are to facilitate community engagement in the monitoring and care of local waterways, and provide data (water quality, waterbug and riparian condition) to support an early warning system for riverine health issues. A key output of this program is the annual Catchment Health Indicator Program (CHIP), which provides a numerical score of catchment health using data collected by Waterwatch volunteers.

In 2013, the CHIP underwent a review by the University of Canberra and it was recommended that the data be displayed in smaller waterway sections defined here as 'reaches'. This allows for a finer scale assessment on the condition of our waterways where data exists and highlights areas in the catchment that are currently unsampled. The 2013–2014 CHIP has taken on this new approach and each reach is accompanied by individual report cards to provide greater context. Given the many changes, this CHIP report is being viewed as a pilot study and feedback from volunteers, catchment managers and scientists will be greatly welcomed. Details on how the reaches were chosen can be found in Appendix II and the methodology for the new CHIP can be found in Appendix III of this report.

Kayaking on the Murrumbidgee River downstream of the ACT.

In 2013–2014, over 160 volunteers from 4 catchment areas, recorded 1,184 water quality surveys and 78 waterbug surveys across 184 Waterwatch sites. This sampling enabled the defining of 63 reaches spread across Ginninderra (8 reaches), Southern ACT (19 reaches), Cooma (15 reaches) and Molonglo (21 reaches), spanning a total catchment area of 8,600 km^2.

The 63 reaches are predominantly made up of more than 2 Waterwatch sites, with the average reach containing 2.9 sites (range: 1–7). This approach increases the confidence in scores by combining data across multiple locations, helping to eliminate site-specific anomalies. The inclusion of riparian condition data into the 2014/15 CHIP will increase confidence in these scores.

Across the 63 sampled sites, CHIP scores varied from Excellent to Poor as per the rating system. No reaches were rated as Degraded which is the lowest rating (**Figure 1**). Nine reaches (14%) were classified as being in excellent health, with four of these coming from the headwater sections of rivers in the Molonglo catchment, two in Southern ACT, and three in Cooma catchments. Conversely, no reaches within the Ginninderra catchment were classified as excellent. This is perhaps not surprising, given the high degree of urbanisation in this catchment.

The vast majority (62%) of reaches were classified as good, with more than 50% of reaches in Cooma, Molonglo, Ginninderra and Southern ACT falling into this classification. There were considerably fewer reaches classified as either Fair (21%) or Poor (3%) (**Figure 1**).

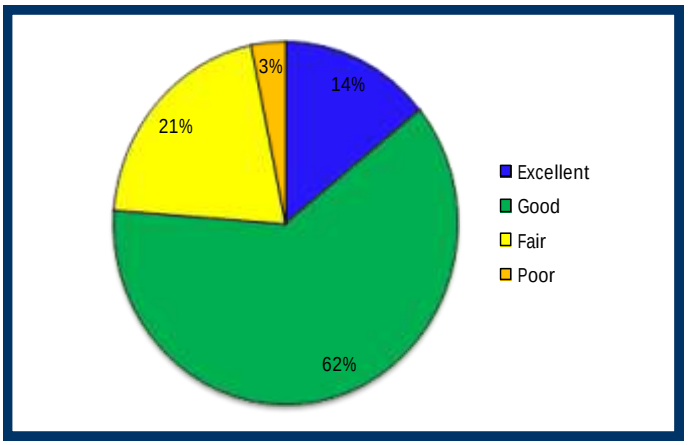

Figure 1: Ratings given to the 63 reaches sampled in the 2013/14 CHIP report. No reaches were rated as 'Degraded'.

Additional sampling is required to improve confidence in some of the reaches. Data input was down overall in 2013/14 due to a reduction in Waterwatch staff numbers. This issue has been rectified for the 2014/15 reporting year and an enhanced dataset is predicted.

A range of key issues emerged as posing threats to the health of our local waterways. High Turbidity levels, due to sediments entering waterways during rainfall events was observed, along with increased levels of nutrients (as indicated by Total Phosphorus and Nitrates) from both rural and urban sources. High Electrical Conductivity was common; however, this may often be a result of the underlying natural geology of the catchments. There was a general trend of decreasing ecological health in the downstream reaches. On a positive note, streamside rehabilitation works taking place in the upper Murrumbidgee, such as riparian vegetation plantings and bank stabilisation works, will help to improve the water quality and overall condition in impacted reaches.

Many thanks to the Waterwatch volunteers. This report would not be possible without you.

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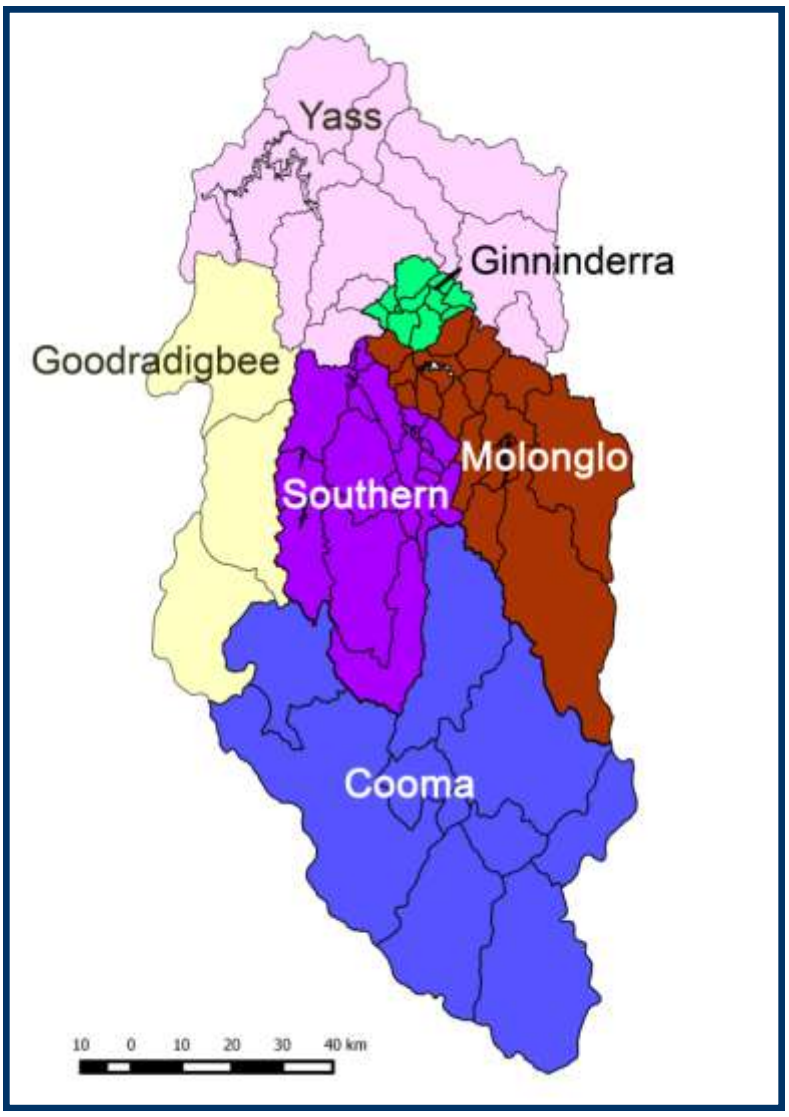
INTRODUCTION

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, an area of more than 13,000km^2.

Four Waterwatch coordinators support volunteers in the major sub-catchments of Cooma, Molonglo, Southern ACT and Ginninderra (**see Map 1**). Each of these sub-catchments will make up sections I to IV of this report. The remaining catchments are Goodradigbee, which has no Waterwatch sampling, and Yass which has recently acquired some volunteers. It is hoped that the Yass Waterwatch data may be included in the 2014/15 report.

As at June 30 2014, Waterwatch had 184 active water quality monitoring sites being monitored by over 160 volunteers.



Map 1: The major sub-catchments of the upper Murrumbidgee. Data from Yass and Goodradigbee is not included in this report.

THE PURPOSE OF THE CHIP

In the past, Waterwatch has produced a report card called the Catchment Health Indicator Program (CHIP), 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 water quality and riparian health issues in their catchment as well as providing a baseline assessment of catchment health to assist natural resource managers and policy-makers in addressing some of these issues. The CHIP is recognised in the new *ACT Water Strategy 2014-44* as a way to *'Enhance knowledge and spatial planning for water and catchment management'*.

The CHIP has not been produced for the entire upper Murrumbidgee for a couple of years as the reporting system underwent a review by the University of Canberra[1]. Based on recommendations from this review, the CHIP has been altered for the 2013/14 year from a sub-catchment approach to one that assesses individual stretches of waterways known as 'reaches'. This will allow for a finer scale assessment on the condition of our waterways where data exists and highlights areas in the catchment that are unsampled.

Given the many changes, the 2013/14 CHIP report is being viewed as a pilot study and feedback from volunteers, catchment managers and scientists will be greatly welcomed.

HOW DOES THE CHIP WORK?

Greater detail about the CHIP philosophy and methodology is outlined in Appendix III.

Waterwatch volunteers and co-ordinators collect data relating to water quality, waterbugs (macroinvertebrates), and riparian condition (river bank vegetation). The frequency of this data collection is outlined in Table 1. Data on riparian condition has not been included in the 2013/14 report due to funding issues (see below) but is currently being collected for the 2014/15 report.

Table 1. Summary of waterway health parameters collected by volunteers and co-ordinators, that are included in the CHIP. These values here reflect current goals, but are not always achieved in all instances.

Data Category	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	Stream Invertebrate Grade Number – Order Level (SIGNAL 2.0)	Biannual (spring & autumn)	Key sites (min 1/reach)
Riparian Condition	Rapid Appraisal Riparian Condition (RARC)	Biennial	All sites

[1] Harrison, E., Dyer, F., Nichols, S., Gruber, B. & Tschierschke, A. (2013) Waterwatch data and catchment health indicator data review . Prepared for ACT Government http://www.act.waterwatch.org.au/Files/Waterwatch_ACT_report_final.pdf

When this data is calculated for an individual reach, it gives us a score that indicates the health of that stretch of waterway. 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 result.

This 2013/14 report will highlight the condition of over 60 reaches across the upper Murrumbidgee catchment. Further information on how these reaches were defined can be found in Appendix II.

FUNDING 2013/14

The 2013/14 financial year was one of uncertainty for Waterwatch. After many years of Federal Government support, funding was not renewed, resulting in the cessation of the three Waterwatch coordinator positions in the ACT Catchment Groups (Molonglo, Southern ACT and Ginninderra). Thanks to the dedication of these coordinators, Waterwatch volunteers continued to get limited support, enabling monitoring to continue while alternative funds were sought. Meanwhile the Cooma Waterwatch coordinator continued to receive valuable support through ACTEW Water.

The limited program funds are reflected in the data collected for this report which were relatively low due to reduced capacity. 2014/15, however, it is looking bright for Waterwatch thanks to generous funding from the ACT Government and continued funds from ACTEW Water. The Waterwatch team looks forward to showing you what they and the volunteers can achieve with this renewed level of support.

And finally a big thank you to the volunteers. This report would not be possible without your continued efforts to collect this important data on the health of our waterways. The Waterwatch team hopes that they have made good use of your data in this report and feel that the best way to say thank you is to ensure your data is made accessible and is being used by stakeholders across the catchment to better manage the upper Murrumbidgee.

Volunteers Fleur and Maree water monitoring at Murray's Corner on the Paddy's River. They have been Waterwatching there for 11 years.

SECTION I: COOMA REGION

CATCHMENT FACTS

The Cooma region catchment comprises of the upper Murrumbidgee, Bredbo, Numeralla, Kybeyan and Badja River subcatchments based on which reaches have been determined for the purposes of the Catchment Health Indicator Program (CHIP). The catchment is dominated by rural landuse. Characteristically, catchments contain modified vegetation with more intensive rural use in the flatter, more fertile areas, while the steeper and more remote areas retain native vegetation and are used less intensively. The catchment contains one major urban centre, Cooma, situated on the Cooma Creek.

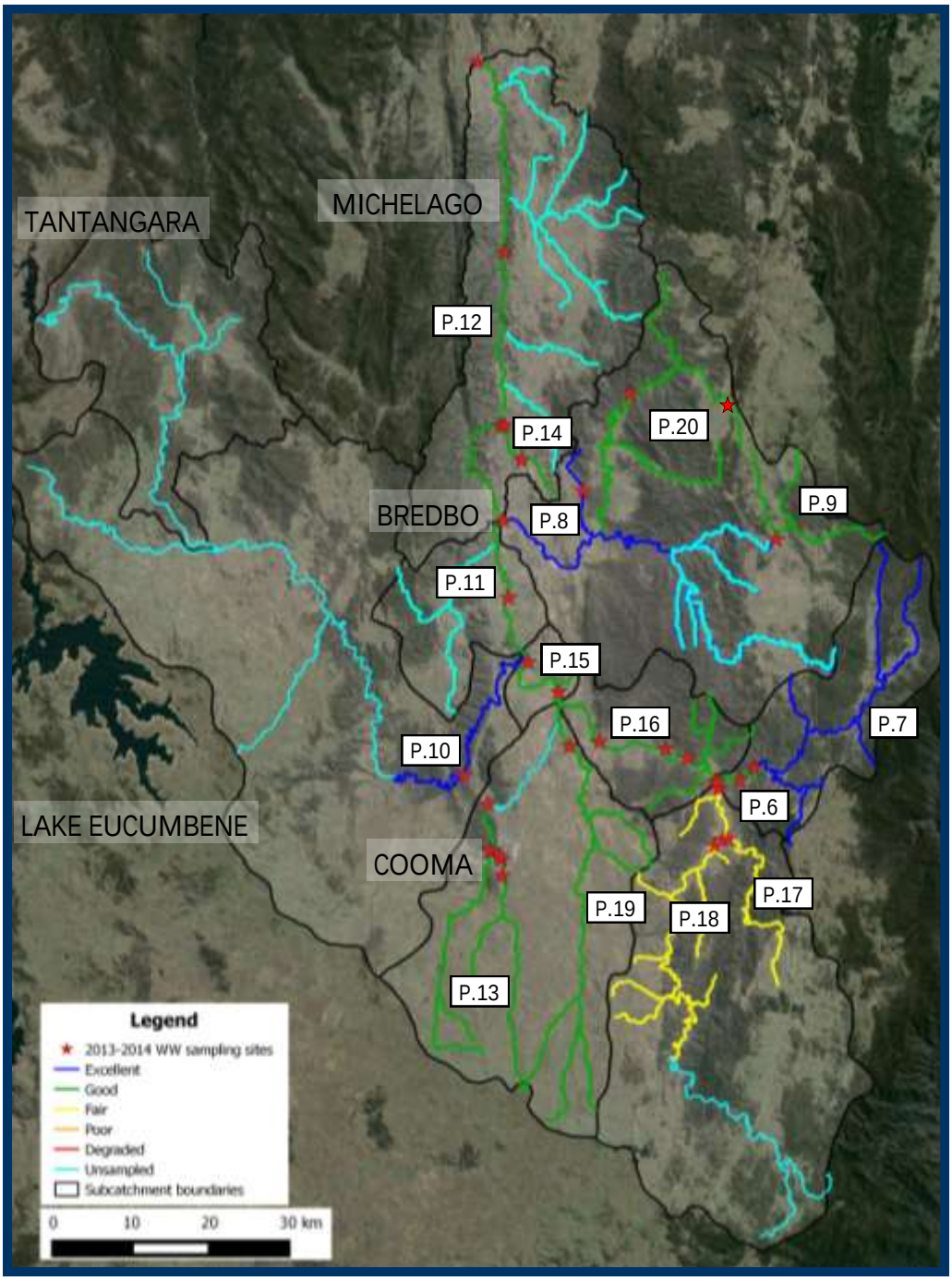
Carp have been recorded in many reaches, however there are notable exceptions including the headwaters of the upper Murrumbidgee, Badja, Kybeyan and Bredbo Rivers. The catchment includes high priority catchments under the Actions for Clean Water Plan (ACWA - an initiative to reduce Turbidity in the upper Murrumbidgee), including the Numeralla and Bredbo Rivers in which investment continues. The Upper Murrumbidgee Demonstration Reach takes in the upper Murrumbidgee River downstream of Bredbo and is currently the focus for riparian rehabilitation and streambank stabilisation works.

Murrumbidgee River below Bredbo.

COOMA CATCHMENT HEALTH SUMMARY

The CHIP ratings for reaches in the Cooma Region catchment (see Map 2) show that river health varies from 'excellent' to 'fair', based on water quality and waterbug samples for each reach. Typically reaches which retain good riparian and in-stream habitat show better catchment health, unless impacted by water quality coming from upstream.

Some catchment areas were not sufficiently sampled to assign a CHIP rating and they have been excluded from this report. Increased sampling in these areas is desirable, especially in the upper sections of the Murrumbidgee and Numeralla Rivers and Cooma and Michelago Creeks. Increased sampling in the lower Bredbo River reaches is also of interest.



MAP 2: CHIP results displayed by reaches for the Cooma region. Click on page numbers to see individual reach report cards.

BADJA RIVER (BAD1)

Undoo to Numeralla River confluence

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: approx. 6km

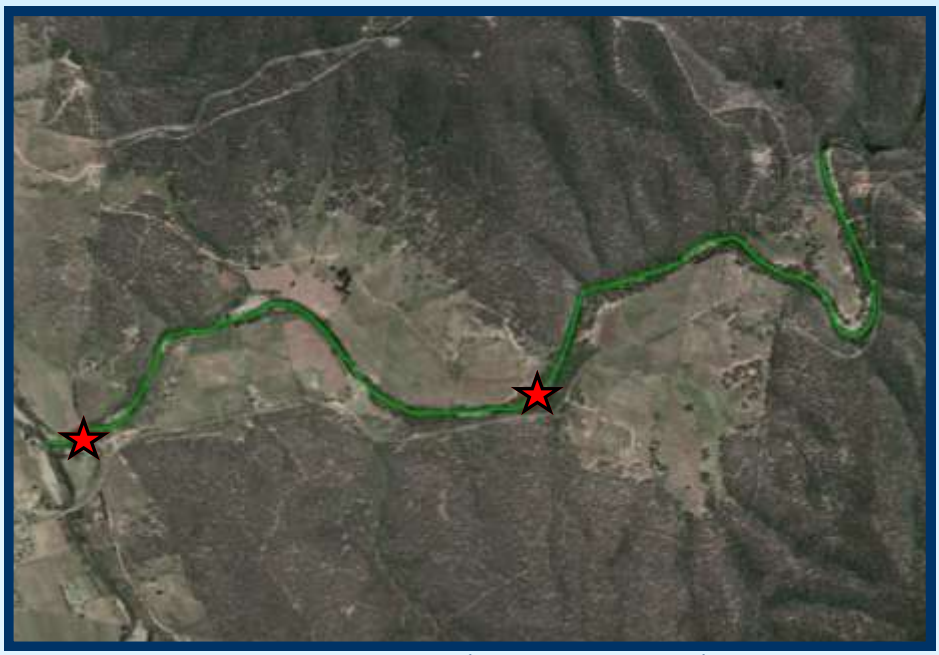
Dominant land uses: Rural

This reach includes the lower section of the Badja River from the bottom end of the Undoo Environment Protection Reserve to the Numeralla River. The reach has open, cleared country used predominantly for grazing (sheep and horses). The (sometimes rather narrow) riparian zones remain intact and continuous on both sides of the river along the reach. In-stream habitat remains largely unmodified.

CHIP SUMMARY

This reach has a 'good' CHIP rating, which is supported by regular water quality monitoring data.

The rating has been influenced by slightly lower Dissolved Oxygen levels (rated as fair). Turbidity is consistently ***'excellent' in this reach,*** highlighting the importance of maintaining good riparian zones and managing floodplains to ensure fine sediment runoff is reduced.



The waterbug score is 'good', which is lower than expected, but may have been influenced by habitat availability at the sample site (sampling of marginal edge habitat) and water quality in the reach.

OTHER NOTABLE OBSERVATIONS

Carp are recorded in this reach. Although riparian zones contain high quality native vegetation, blackberry does occur. This is currently the subject of a blackberry program being carried out by Numeralla Landcare, with control occurring in the next year.

BADJA RIVER (BAD2)

Headwaters to Undoo

2013/14 CHIP RESULT A-

REACH FACTS

Reach network length: approx. 28 km

Dominant land uses: Rural and conservation

The upper Badja River reach encompasses the headwaters of the Badja River which include the Badja Swamps Nature Reserve. The upper section of this reach contains cleared open country predominantly used for grazing and then falls steeply through unmodified, steep country which contains high quality riparian zones and aquatic habitat. The Undoo Environment Protection Reserve is at the bottom of the reach.

CHIP SUMMARY

The CHIP rating for this reach is ***'excellent' as indicated from data*** consistently generated from a single site at the bottom end of the reach.

The CHIP rating is influenced by the water quality results which ***show consistently 'excellent' scores*** for Turbidity and Electrical Conductivity, however Dissolved Oxygen may be slightly low. The rating reflects the quality of the riparian zones and catchment integrity surrounding this reach.

The waterbug score is 'good', which is lower than expected given the water quality data, but in-stream habitat quality may be a factor which has influenced the score.

OTHER NOTABLE OBSERVATIONS

The riparian zones of the reach are of high quality and are relatively free of willow, broom and blackberry due to previous control programs carried out by Numeralla Landcare. Carp sightings are not recorded in this reach.

BREDBO RIVER (BRD1)

Cowra Creek to Murrumbidgee River confluence

2013/14 CHIP RESULT A+

REACH FACTS

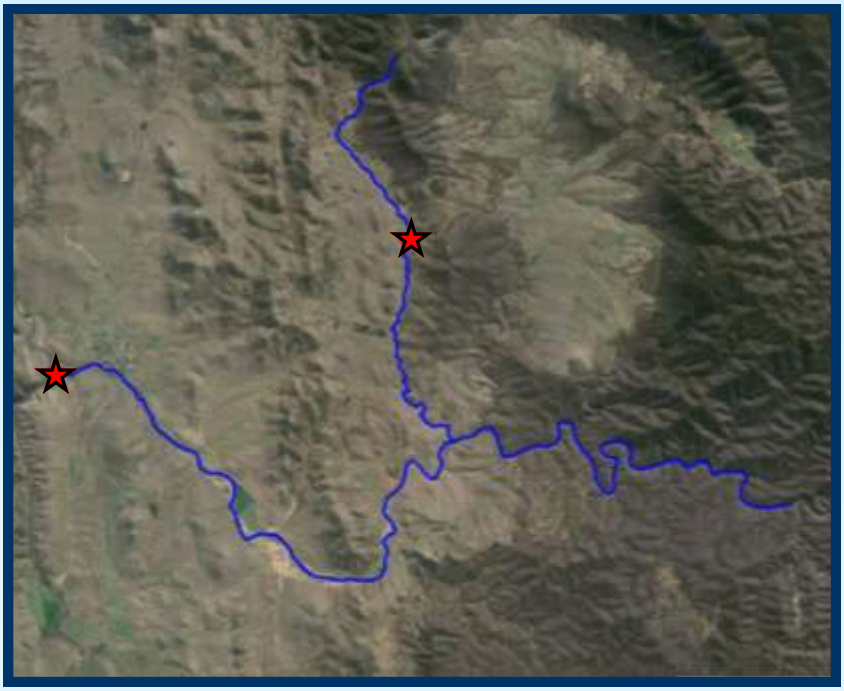
Reach network length: approx. 20 km

Dominant land uses: Rural including dryland cropping and grazing

This reach includes the lower Bredbo River and all tributaries (excluding the Strike-A-Light Creek) up to the confluence of the Cowra Creek. This reach is characterised by a floodplain valley which used for agriculture. This section is highly modified and considerable amounts of sediment are deposited instream. The upper section of the reach flows out of remote, largely unmodified gorge country.

CHIP SUMMARY

The CHIP rating for this reach is *'excellent', however this is based on* a few water quality data points and an excellent waterbug score. Further sites and data collection is a priority to enhance confidence in the CHIP score.



Data from previous years indicates that Bredbo River can at times be subject to high Turbidity levels (usually after rain). Electrical Conductivity and Total Phosphorus can also be slightly elevated compared to other reaches.

The waterbug score for this reach is derived from a sample taken from plentiful edge habitat at the Bredbo River confluence.

OTHER NOTABLE OBSERVATIONS

Carp are often reported in large numbers in the lower section of this reach. No reports have currently been made for the upper section. This is a priority ACWA catchment and several erosion sites have so far been stabilised on tributaries of the Bredbo River.

UPPER BREDBO RIVER (BRD2)

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: approx. 14km

Dominant land uses: Rural

This reach includes the headwaters of the Bredbo River, upstream of the Peakview Road Crossing including Cutmore Creek. The reach flows through a mix of cleared and unmodified country, predominantly used for grazing purposes. Small scale pine plantations have also been established in the catchment. Riparian zones are in fair (cleared) to excellent (unmodified) condition and instream habitat is of good quality.

CHIP SUMMARY

The CHIP rating for this reach is *'good', with data generated from* data regularly collected at the downstream end of the reach. Further sites throughout the reach are desirable.

The rating is influenced by slightly elevated Total Phosphorus and lower Dissolved Oxygen levels which *both rate as 'fair' as well as the* waterbug sample results.

The waterbug score was 'fair' due to high numbers of very sensitive water bugs, but a lack of diversity otherwise. This indicates that there may have been a disturbance event in the water bug population which is affecting diversity and lowering the sample score.

OTHER NOTABLE OBSERVATIONS

Carp sightings have not been reported for this reach. High quality riparian zones and high levels of groundcover maintained throughout the reach catchment are likely to contribute to consistently low turbidity levels in this reach even in high runoff events.

MURRUMBIDGEE RIVER (CMM3)

Bridle Creek confluence to Numeralla River confluence

2013/14 CHIP RESULT A

REACH FACTS

Reach network length: approx. 31km

Dominant land uses: Rural and conservation

This reach includes the Murrumbidgee River from the Bridle Creek confluence to the Numeralla River confluence. The bottom section of the reach has open, cleared country used for predominantly grazing purposes. The upper section includes the Binjura Nature Reserve, where the 'Cooma Gorge' is found. Good quality riparian and aquatic habitat are found in this gorge section.

CHIP SUMMARY

The CHIP rating for this reach is 'excellent', based mainly on the waterbug surveys. The good riparian and aquatic habitat found in the upper sections of this reach are likely to be an important factor supporting this result.

The limited water quality data that does exist for this CHIP period shows that slight increases in Turbidity and lower Dissolved Oxygen levels have been detected and require further investigation along this reach.

Further sites and water quality data collection is a priority to enhance confidence in the CHIP score.

OTHER NOTABLE OBSERVATIONS

Carp are reported from Bridle Creek downstream. Willows occur throughout the reach from scattered (upstream) to dense infestations downstream. Willows have been removed in the Mittagang Crossing area, where Cooma draws its water supply.

MURRUMBIDGEE RIVER (CMM4)

Numeralla River confluence to Bredbo River confluence

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: approx. 12km

Dominant land uses: Rural

This reach includes the upper Murrumbidgee River from the Numeralla River confluence to Bredbo River confluence (including Murrumbucca Creek). The river flows through open, cleared country where the predominant landuse is grazing and irrigated agriculture (vegetables and lucerne). The reach contains highly modified, non-native riparian vegetation zones.

CHIP SUMMARY

The CHIP rating for this reach is 'good'. The rating is influenced by slightly raised Total Phosphorus, Electrical Conductivity and pH water quality readings. These are likely to be influenced by landuse in the reach area.

Water quality data collected in this reach shows that Turbidity can become elevated at times, associated with runoff and discharge events.

The waterbug rating for the reach is fair, which is likely to be influenced by the quality of riparian zones and in-stream habitat (both highly modified), as well as the water quality found in this reach.

OTHER NOTABLE OBSERVATIONS

Medium to dense willow infestation and instream gross sediment deposition has simplified aquatic and riparian habitat in the Murrumbidgee River. Carp are commonly sighted. ACWA streambank erosion control works have been carried out in this reach.

MURRUMBIDGEE RIVER (CMM5)

Bredbo River confluence to Willows Road

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: approx. 45km

Dominant land uses: Rural and conservation

This reach takes in the upper Murrumbidgee River from the Bredbo River confluence to Willows Road just north of Michelago. This reach flows through the areas known as the Bredbo and Colinton Gorges which form the upper and lower sections of the reach. Michelago creek is a tributary that discharges into this reach. The gorges contain good quality riparian and aquatic habitat.

CHIP SUMMARY

The CHIP rating for this reach is 'good' and has been generated from data collected mainly from the top and bottom end of the reach.

The rating is influenced by higher pH, elevated Turbidity and lower Dissolved Oxygen levels which have been picked up by water quality monitoring. Elevated Turbidity is usually associated with rainfall and runoff events. Water quality in the reach reflects the sum effect of water quality inputs from catchments upstream.

The waterbug score is good, reflecting the quality of riparian and aquatic habitat in the reach.

OTHER NOTABLE OBSERVATIONS

The reach includes Bush Heritage Australia's Scottsdale Reserve and the NSW section of the Upper Murrumbidgee Demonstration Reach whose partners aim to rehabilitate riparian and aquatic habitat for native fish. Carp are commonly sighted in this reach.

COOMA CREEK (COO1)

Headwaters to Rock Flat Creek

2013/14 CHIP RESULT B-

REACH FACTS

Reach network length: approx. 26km

Dominant land uses: Rural and urban

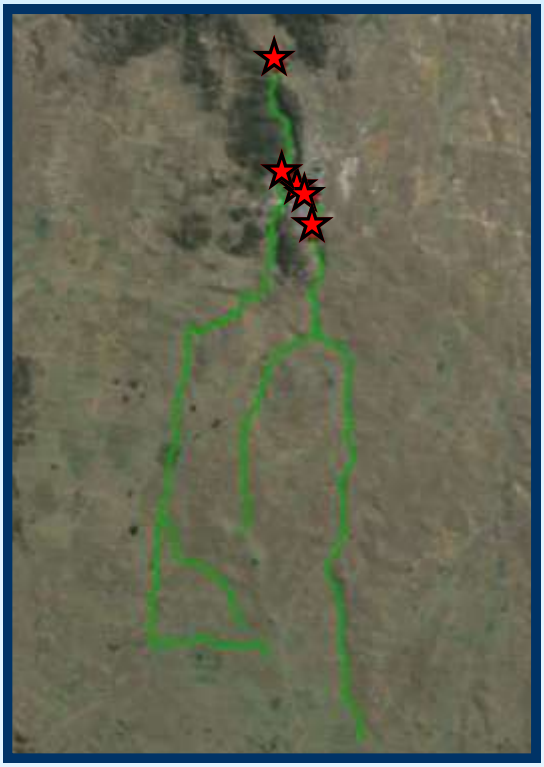
This reach includes the Cooma Creek and Cooma Back Creek catchments from their headwaters down to Mittagang Road Crossing. The top of the Cooma Creek flows through predominantly open basalt country, dominated by grasslands and hence is used for dryland cropping and grazing agriculture. The Cooma and Cooma Back Creeks run through the township of Cooma, where they are linked to the stormwater system.

CHIP SUMMARY

The CHIP rating for this reach is 'good', with data generated consistently at sites situated throughout the township of Cooma and downstream.

Water quality readings influencing the rating include consistently poor Electrical Conductivity levels, which are partly natural and due to the geology of the upper catchment. Total Phosphorus are consistently elevated ***and Dissolved Oxygen low (both rating as 'poor') and*** this is most likely due to urban influences.

The waterbug score is 'good' reflecting abundant in-stream habitat in the creek. The samples show a greater dominance of more tolerant water bugs.



OTHER NOTABLE OBSERVATIONS

The Keep Cooma Creek Clean campaign is ongoing and aims to address urban water quality impacts in stormwater including litter. The Cooma and Cooma Back Creek catchments are priority ACWA catchments. Carp have been reported in the reach.

GUNGOANDRA CREEK (GUD1)

Headwaters to Murrumbidgee River

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: approx. 9km

Dominant land uses: Rural and conservation

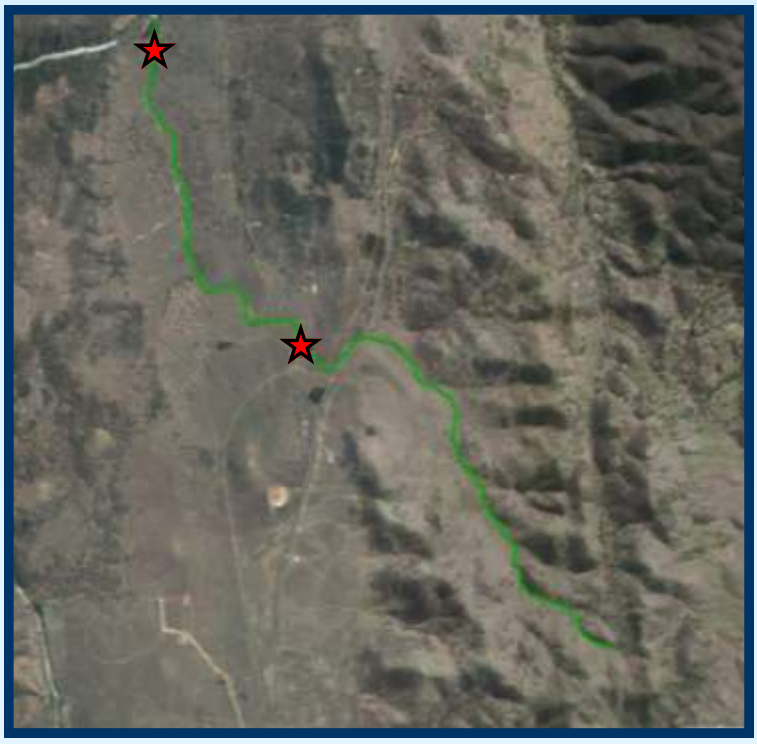
This reach includes the length of the Gungoandra Creek which flows into the upper Murrumbidgee River downstream of Bredbo Gorge. The upper section of the creek has been cleared and is grazed, while the lower section runs through Bush Heritage ***Australia's Scottsdale Reserve. Revegetation is occurring on the reserve in the creek's*** catchment area and stands of in-stream macrophytes have also been established .

CHIP SUMMARY

The CHIP rating for this reach is 'good' with data consistently measured at two sites at the upstream and downstream end of the Scottsdale Reserve.

The rating is influenced by higher Electrical Conductivity (EC) values, which are natural and due to the geology of the catchment. EC values show a decrease as water is filtered through the extensive reed beds occurring between the sampling ***sites. Turbidity is consistently 'excellent'.***

The waterbug score is 'good' and sampled in abundant edge habitat. The score is likely to be influenced by the EC levels and reduced riparian habitat which is showing signs of regeneration.



OTHER NOTABLE OBSERVATIONS

Scottsdale Reserve has been the focus of several ACWA works including leaky weirs and in-stream stabilisation of a major headcut on Gungoandra Creek, which is improving water quality. Oriental weatherloach (pest fish) have been sighted in this reach.

NUMERALLA RIVER (NUM1)

Rose Valley Road to Murrumbidgee River confluence

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: approx. 17 km

Dominant land uses: Rural

This reach includes the lower section of the Numeralla River from the Rose Valley Road Crossing to its confluence with the Murrumbidgee River. The catchment includes wide floodplain areas on both sides of the Numeralla River which are used for agriculture including dryland and irrigated cropping and grazing. Riparian zones are highly modified and gross sediment deposition is widespread in the river.

CHIP SUMMARY

The CHIP rating for this reach ***is 'good', based on data*** generated from two sites within the reach.

The rating is influenced by slightly elevated Total Phosphorus levels (rated as fair) and the waterbug score. All other water quality parameters were rated as good to excellent. Turbidity is usually excellent, but can be elevated on association with high rainfall and runoff events.

The waterbug score is 'fair'. Factors affecting this score are likely to include poor habitat quality in-stream, water quality and highly modified riparian zones.

OTHER NOTABLE OBSERVATIONS

This is a priority ACWA catchment and erosion risk was assessed to be very high. Carp are often reported in this reach. Willows are also able to readily form dense infestations from seeding events which take hold in large exposed sand bars.

NUMERALLA RIVER (NUM2)

Badja River confluence to Rose Valley Road

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: approx. 14km

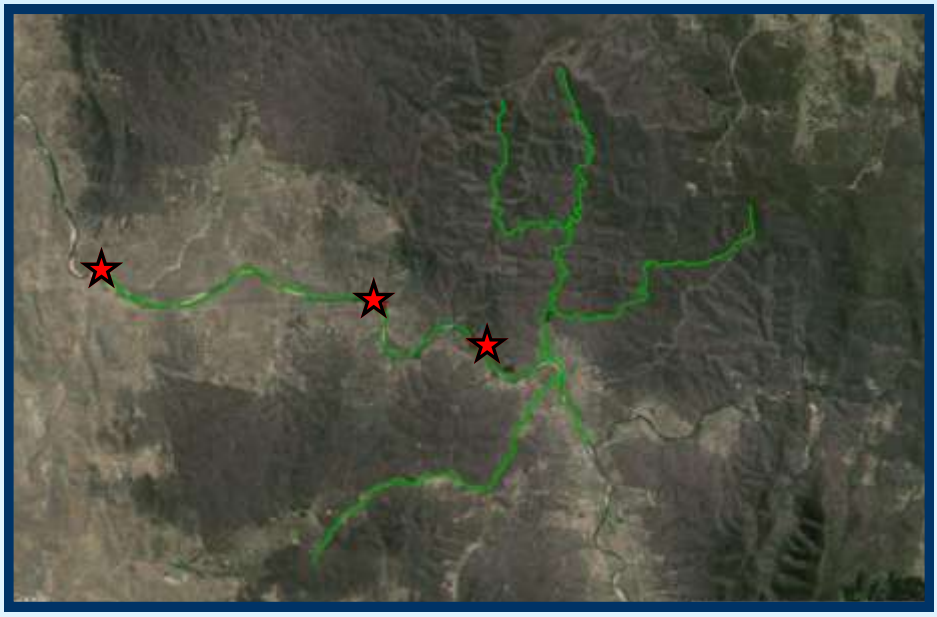
Dominant land uses: Rural and rural residential

This reach includes the Numeralla River from the Rose Valley Road Crossing to the Badja River confluence, including the Cowra Creek catchment. The reach is characterised by floodplain areas used for agriculture including dryland cropping and grazing at various levels. It has modified riparian zones and sediment deposition is also found in-stream. Tributaries feeding into the Numeralla River have retained good native vegetation.

CHIP SUMMARY

The CHIP rating for this reach ***is 'good' and is based on data*** from three sites along the Numeralla River which are consistently monitored.

The rating is influenced by lower Dissolved Oxygen and higher Turbidity levels in the reach (both rated as poor) and the waterbug score. Turbidity is usually elevated in association with rainfall and runoff events.



The waterbug score is 'fair'. Factors likely to be influencing the score are water quality and reduced instream habitat quality at sampling sites. The Rose Valley Crossing site also lacks high quality riparian vegetation.

OTHER NOTABLE OBSERVATIONS

This is a priority ACWA catchment for which erosion risk was assessed to be very high. ***The tributary 'Rose Creek' is an identified high priority ACWA site. Carp sightings are*** reported in this reach including spawning in reeds upstream of Rose Valley Crossing.

KYBEYAN AND NUMERALLA (NUM3)

2013/14 CHIP RESULT C+

REACH FACTS

Reach network length: approx. 40km

Dominant land uses: Rural and conservation

This reach includes the Kybeyan River catchment and the Numeralla River downstream of the Kybeyan River confluence to the Badja River confluence. The Numeralla River in this reach is flanked by wide floodplains used for agriculture, including dryland cropping and grazing. The Kybeyan River has open, modified grazing country at the top of the reach and native vegetation downstream such as the Kybeyan Nature Reserve.

CHIP SUMMARY

The CHIP rating for this reach ***is 'fair', based on limited data*** from two sites. More data is required to increase confidence in the CHIP rating and additional sites are desirable, especially along the upper Kybeyan River.

Water quality data shows that ***Turbidity is mostly 'excellent'*** in this reach, but can be elevated in association with high rainfall and runoff events.

The CHIP rating is highly influenced by the waterbug score which is 'fair'. Factors which may contribute to this score include water quality and poorer in-stream and riparian habitat at sampling sites.

OTHER NOTABLE OBSERVATIONS

Numeralla village is situated at the bottom end of this reach. The reach is included in a ***priority ACWA catchment. Numeralla Fishing Club hold an annual 'carp-out' event and*** carry out a native fish stocking and re- snagging program, including sites in this reach.

NUMERALLA RIVER (NUM4)

Headwaters to Kybean River confluence

2013/14 CHIP RESULT C+

REACH FACTS

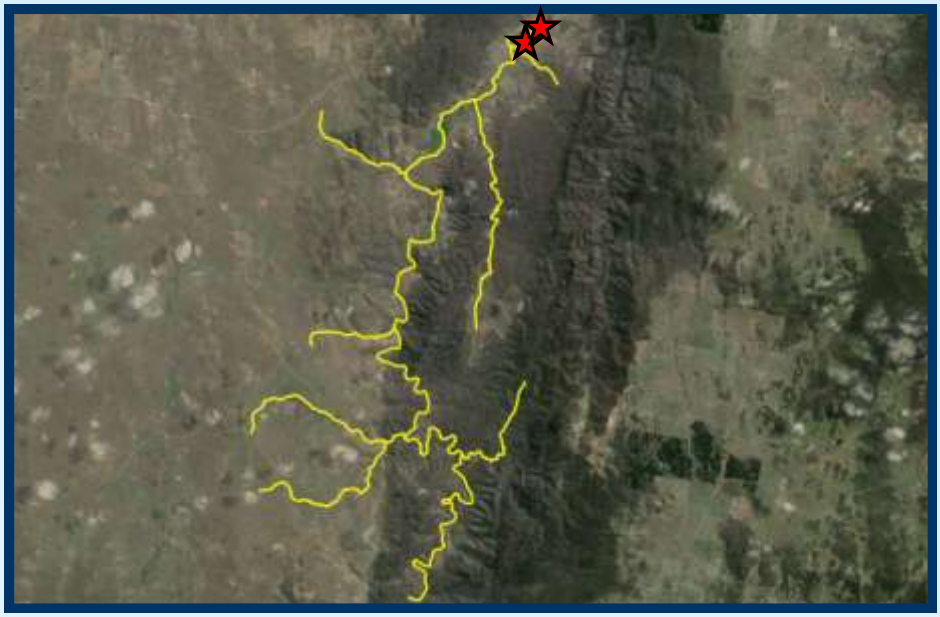
Reach network length: approx. 38km

Dominant land uses: Rural and conservation

This reach includes 28km of the Numeralla River upstream of the Kybeyan River confluence. Riparian zones in these parts of the reach are highly modified and used for dryland cropping and grazing agriculture. Sections of the upper reaches retain native vegetation including the Dangelong Nature Reserve. These areas have historically been unmodified and good riparian and in-stream habitat remains.

CHIP SUMMARY

The CHIP rating for this reach ***is 'fair', based primarily on the*** waterbug sample. There was limited water quality data available for sampling sites which all occur at the downstream end of the reach. More sampling sites in the upper catchment is therefore desirable.



Water quality data shows that Turbidity levels can be elevated especially in association high rainfall and runoff events.

The waterbug score was 'fair' and factors which have most likely influenced this score include water quality in the reach and the quality of in-stream habitat and riparian zones at sampling sites.

OTHER NOTABLE OBSERVATIONS

This reach is included in a high priority ACWA catchment. Two streambank erosion sites have been stabilised by the ACWA project at the bottom end of the reach. Carp sightings are reported for this reach up to Mt Forest Road Crossing.

ROCK FLAT CREEK (ROC1)

Headwaters to Cottage Hill Road crossing

2013/14 CHIP RESULT B-

REACH FACTS

Reach network length: approx. 42km

Dominant land uses: Rural

This reach includes the entire Rock Flat Creek catchment from its headwaters down to the Cottage Hill Road Crossing. The catchment flows through predominantly open basalt country, dominated by grasslands and hence is used for grazing agriculture. Wide floodplains at the bottom end of the reach have been historically prized for cropping and hence riparian zones are highly modified in this catchment.

CHIP SUMMARY

The CHIP rating for this reach is 'good', based on data from two sites from the middle and bottom end of the reach. More sites in the top end and near the Cooma Creek confluence are desirable.

The rating is influenced by consistently high Electrical Conductivity (rated as poor) and alkaline pH (rated fair) which are due to geological influences in the catchment. Turbidity values are usually low, however can be elevated in association with high rainfall and runoff events

The waterbug score is 'good', with samples taken from gravel and cobble bars found at the sample sites.

OTHER NOTABLE OBSERVATIONS

The Rock Flat Creek catchment is a medium priority ACWA catchment which includes an identified high priority ACWA site. Riparian zones are highly modified and in-stream habitat (eg macrophytes) is reduced in some areas due to unlimited stock access.

STRIKE-A-LIGHT CREEK (STR1)

Headwaters to Jerangle Road

2013/14 CHIP RESULT B-

REACH FACTS

Reach network length: approx. 38km

Dominant land uses: Rural

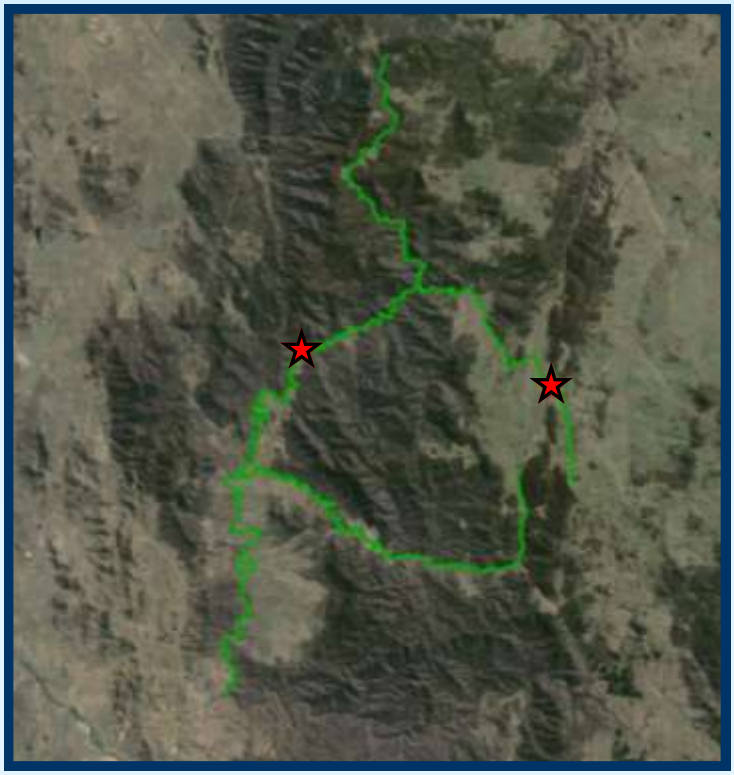
This reach includes the entire Strike-A-Light Creek catchment from its headwaters down to the Jerangle Road bridge. The catchment includes both cleared open country, utilised for predominantly grazing agriculture at the top and bottom ends of the reach. In these areas riparian vegetation has been modified. The middle of the reach is largely native vegetation with intact riparian areas and good instream habitat.

CHIP SUMMARY

The CHIP rating for the reach is 'good', based on two sites on the reach which are consistently monitored.

The rating is influenced by slightly alkaline pH levels which are most likely to be due to natural factors. Total Phosphorus levels were also found to be fair and Dissolved Oxygen levels were found to have a poor rating. Turbidity is usually found to be low.

The waterbug score is 'fair' and is likely to be influenced by water quality and perhaps reduced in-stream habitat at some sampling sites. At lower sites modified riparian zones may also be a factor.



OTHER NOTABLE OBSERVATIONS

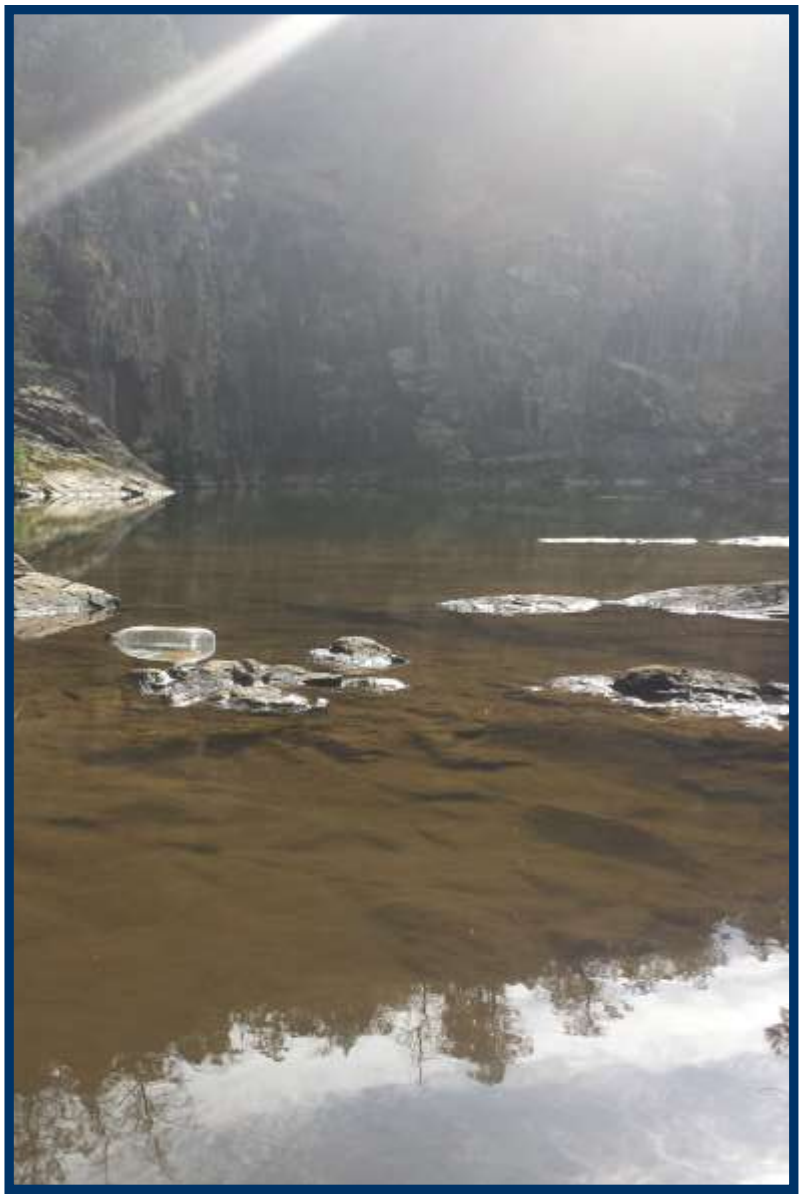
This reach is included in a moderate priority ACWA catchment. An identified ACWA site exists in the catchment, but was assessed as a low priority site. No carp sightings have been reported for this reach. Galaxias (small native fish) have been sighted.

SECTION II: GINNINDERRA

CATCHMENT FACTS

Ginninderra Creek is of major importance in both a local and regional context. Over 35% of ACT residents live in this Catchment making it the most urbanised Catchment in the ACT. It carries substantial urban water runoff from both established and newly developing suburbs directly into the Murrumbidgee River.

Ginninderra Creek itself begins in the upper reaches of Gungahlin within the Mulligans Flat Nature Reserve and enters the Murrumbidgee after passing through the Catchments most significant and best preserved remnant ecosystem; the Ginninderra Gorge including the spectacular upper and lower falls. Gooromon Ponds Creek Catchment joins Ginninderra Creek near Dunlop and captures run off from much of the NSW land around Wallaroo and also includes Hall creek.



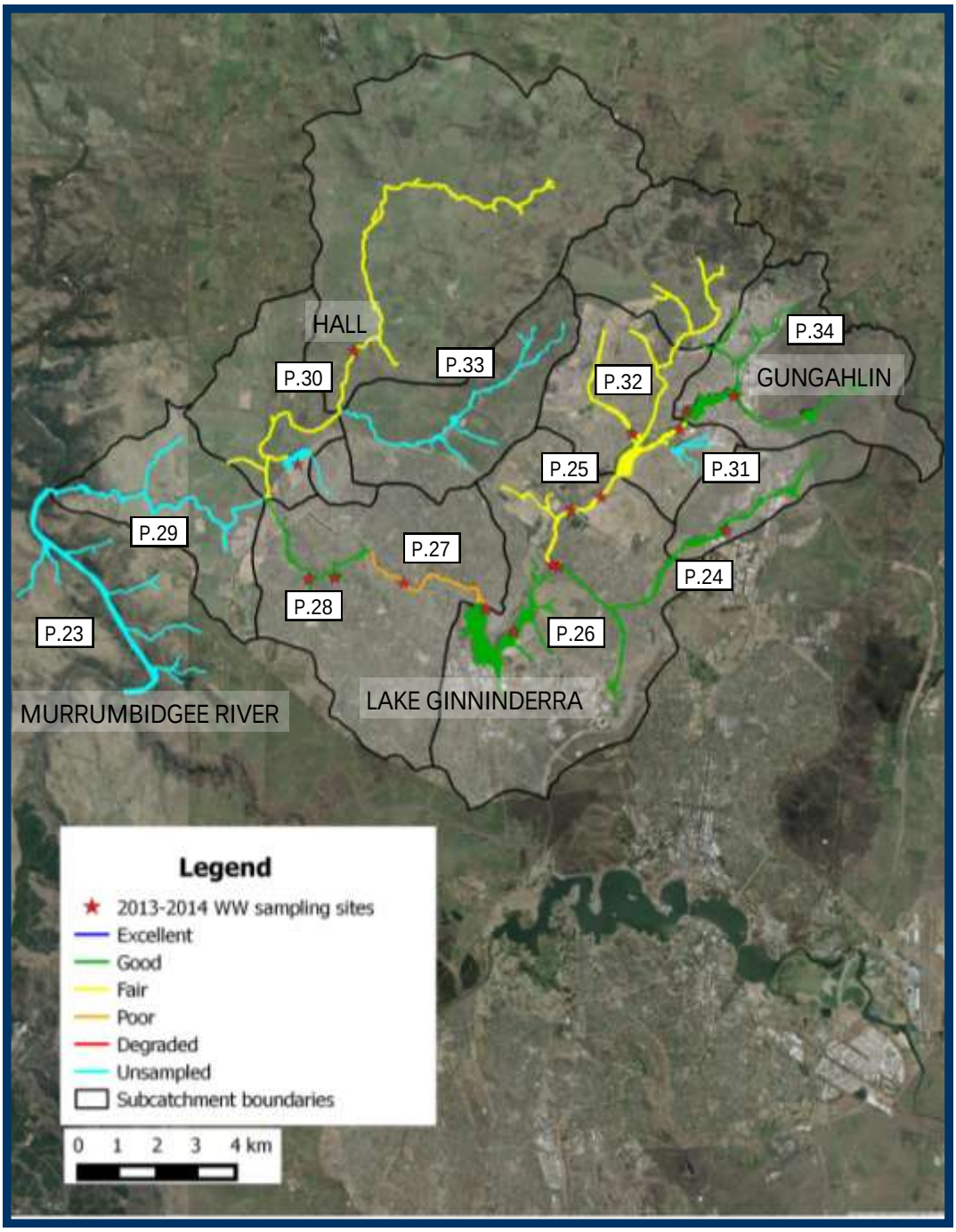
Ginin-ginin-derry living up to the Ngunawal name thought to mean **"Sparkling" or "throwing out little rays of light"**

Steady development in Canberra's north has impacted significantly over the past 30 years with sediment from development sites and spreading 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 such as Evatt, Umbagong district park, Macgregor and Dunlop.

Ginninderra Waterwatch Volunteers have been monitoring this catchment since 1997.

GINNINDERRA CATCHMENT HEALTH SUMMARY

CHIP ratings for the Ginninderra Catchment show water quality mostly in the good to fair range (see Map 3). The only exception was the poor rating for the GIN3 reach (directly downstream of Lake Ginninderra) which was based solely on waterbug results and can not be compared to other reach scores. Waterbug sampling showed poorer results than the monthly physical/chemical monitoring. This is to be expected as waterbugs give a more complete measure of ecosystem health and are also impacted by water flow patterns which are significant in this highly modified Catchment. Reaches that did not meet data density are included in reports as well as new reaches that will be monitored in 2014/15.



MAP 3: CHIP results displayed by reaches for Ginninderra catchment. Click on page numbers to see individual reach report cards.

Murrumbidgee River (CMM10)

Molonglo River confluence to ACT border

2013/14 CHIP RESULT Data Deficient

REACH FACTS

Reach network length: approx. 10km

Dominant land uses: Rural/River Corridor

Starting below the confluence of the Molonglo River this reach includes mostly rural land and Murrumbidgee River reserve to the confluence with Ginninderra Creek. The reach also includes some section of gorge country and the upper section of the reach receives the outflow from the Lower Molonglo sewerage treatment plant.

CHIP SUMMARY

Monitoring will commence in 2014/15

OTHER NOTABLE OBSERVATIONS

On the eastern side of the reach a the proposed housing development of West Belconnen is planned to commence in 2015. Baseline monitoring prior to development is critical in order to measure the impact of the development on the Murrumbidgee River.

Gungaderra Creek (GDC1)

2013/14 CHIP RESULT B-

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 up stream of Lake Ginninderra. The reach also includes stormwater channel from the University of Canberra and Canberra Stadium and has moderate urban stormwater inflow.

CHIP SUMMARY

From 2 sites there were 18 water quality and no waterbug surveys recorded.

Overall the reach water quality results were good. The exception was Turbidity with fair readings consistently between 30-60 NTU. All other parameters were mostly in the good range.

Development in the upper reaches of both main tributaries contributed to higher Turbidity for this reach. No waterbug or RARC data was collected for this year so habitat value is missing from this report card. When data is collected for these latter parameters in addition to water quality, a better understanding of the overall ecological health of the reach will be realised.

OTHER NOTABLE OBSERVATIONS

This reach flows into Giralang pond which had a "black water" event during this period causing low DO and resulting in a fish kill event. Only large pest species (Carp) were recorded in the event which may indicate that native species no longer inhabit this pond.

Ginninderra Creek (GIN1)

Crace to Giralang

2013/14 CHIP RESULT C+

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 the new development of Crace. The middle of the reach receives runoff from the CSIRO field test facility. The downstream section flows through the Old Palmerville township historic site and Landcare Forest. The end point for this reach is Giralang Pond which is the only small stream pond on the Ginninderra Creek.

CHIP SUMMARY

From 3 sites there were 15 water quality and 3 waterbug surveys recorded.

Overall the reach water quality was fair. With Turbidity consistently between 30-60 NTU. Dissolved Oxygen was also fair with most samples between 30-80 % saturation. All other parameters were mostly in the good range. The development of Crace contributed to higher Turbidity for this reach during this period.

Of the 3 waterbug surveys 2 showed poor results and 1 fair. At all sites only tolerant and very tolerant bugs groups were mostly found. No RARC data was collected for this year. As habitat through this section is relatively good, poor bugs results are likely due to poorer water quality or flow patterns.

OTHER NOTABLE OBSERVATIONS

Outflow from Gungahlin Pond may contribute to poor waterbug scores as timing of water releases may impact significantly on waterbug population.

Lake Ginninderra (GIN2)

2013/14 CHIP RESULT B+

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, including the new development suburb of Lawson. The other inflow joins at the southern end of the lake and is mostly urban stormwater that flows into the newly redeveloped Eastern Valley Way wetland.

CHIP SUMMARY

From 2 sites there were 13 water quality and 1 waterbug surveys recorded.

Overall the reach water quality was good. Fair scores were recorded for pH (8-8.6) and Dissolved Oxygen saturation (65-80 %) with all other parameters ranked good. The 1 waterbug survey showed good results with a mix of tolerant and sensitive groups.

During the redevelopment of the wetland on the southern arm of the lake, no waterwatch data was collected there during this reporting period. Normal monitoring of the will recommence in 2014/15.

OTHER NOTABLE OBSERVATIONS

The newly completed Eastern Valley way wetland was completed with extensive plantings of macrophytes and riparian species. The macrophytes have suffered from high numbers of water birds which have significantly reduced the success of these plantings.

Ginninderra Creek (GIN3)

Dam wall to Ginninderra Drive

2013/14 CHIP RESULT D+

REACH FACTS

Reach network length: approx. 4km

Dominant land uses: Urban

Starting below the Lake Ginninderra dam wall this reach is entirely old established suburbs with high urban stormwater inflow and outflow from the Lake. Like the rest of the lower creek this section is characterised by abundant reed growth that resulted from the willow removal project in 2000.

CHIP SUMMARY

There were no water quality surveys, but 1 waterbug survey recorded.

From 1 waterbug survey the water quality is recorded as poor, however this site may be considered data deficient because no physical water quality surveys were recorded.

Poor waterbug scores may indicate poor water quality but may also be impacted by flow patterns. As this reach has good instream habitat, poor results are of concern but with only 1 sample this needs to be checked with follow up surveys. With Waterwatch funding restored, greater sampling is envisaged for 2014/15 to enable a more complete analysis.

OTHER NOTABLE OBSERVATIONS

Volunteers were not able to be maintained in this reach due to funding cuts.

Ginninderra Creek (GIN4)

Umbagong to Dunlop

2013/14 CHIP RESULT B

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 Ponds Creek. It has high urban runoff from old established suburbs and also includes the inflow from Kippax Creek. The downstream section has some inflow from the developing suburb of Macgregor West.

CHIP SUMMARY

From 2 sites there were 22 water quality and 2 waterbug surveys recorded.

Water quality was good for this reach with the results for Kippax Creek poorer than Ginninderra Creek. Kippax Creek recorded the poorer results in Electrical Conductivity (400-500µS) and Total Phosphorus (0.06-0.15 mg/L). Other parameters were mostly good.

The waterbug surveys showed similar results with Ginninderra Creek recording better results than Kippax Creek.

Infill development over this time at the Kippax shopping centre area may have contributed to the reduced water quality in Kippax Creek.

OTHER NOTABLE OBSERVATIONS

This reach was a significant part of the lower Ginninderra Creek riparian restoration project and adult Poplar removal project.

Ginninderra Creek (GIN5)

Ginninderra Falls

2013/14 CHIP RESULT Data Deficient

REACH FACTS

Reach network length: approx. 10km

Dominant land uses: Urban/Rural Fringe

Starting at the confluence with Gooromon Ponds, the upstream section has inflow from the developing suburb of Macgregor West. This then flows through rural fringe land into NSW and through the gorge country of Ginninderra Falls and finally joins the ***Murrumbidgee below Cusack's Crossing.***

CHIP SUMMARY

Monitoring will commence in 2014/15

OTHER NOTABLE OBSERVATIONS

The Ginninderra Falls area is the most intact remnant habitat in the entire Ginninderra catchment. The middle section of this reach was part of the lower Ginninderra Creek riparian restoration project.

Gooromon Ponds Creek (GOO1)

Headwaters to Ginninderra Creek

2013/14 CHIP RESULT C+

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 creek with intermittent pools. This creek contains sections of moderate erosion and has mostly low habitat value.

CHIP SUMMARY

From 1 site there were 11 water quality and no waterbug surveys conducted.

Overall the reach water quality results were good. The exception was high Electrical Conductivity readings (560-1390 µS) which is consistent with long term monitoring of this creek and is believed to be a natural geologic influence or mild salinity issue. Fair results for Dissolved Oxygen are also consistent with long term monitoring and are a result of poor in-steam vegetation, mostly low water levels and irregular flow patterns.

OTHER NOTABLE OBSERVATIONS

The newly formed Wallaroo Landcare group have shown an interest in improving vegetation around waterways and properties. This reach will be monitored more regularly during 2014/15 to provide baseline data prior to improvement works.

The Valley Ponds (GUN1)

2013/14 CHIP RESULT Data Deficient

REACH FACTS

Reach network length: approx. 2km

Dominant land uses: Urban

Originally a old farm dam and artificial seepage grassland, this site was a unique habitat for this catchment.

Redeveloped into urban wetland for the Gungahlin town centre and parts of Palmerston. This site is now a high quality education and recreation wetland.

CHIP SUMMARY

Due to the closure of the site for redevelopment no data was collected for this year. Waterwatch data monitoring will resume in 2014/15. Plantings have been successful and habitat value appears to be excellent with diverse grass and mid storey plants and successful macrophyte growth. The wetland will be officially opened in 2015 with the local community encouraged to help maintain the area if interested. Whilst no longer unique the new wetland does offer the local community improved public amenity and connection to wetland environments.

OTHER NOTABLE OBSERVATIONS

Prior to redevelopment this site contained a disconnected ephemeral frog pond which is now connected to the main wetland. Gambusia present in the main wetland are now in the frog pond and water level will be maintained at higher levels. To improve habitat for frogs, consideration should be given to returning the ephemeral cycle of this pond.

Gungahlin Pond (GUN2)

2013/14 CHIP RESULT C-

REACH FACTS

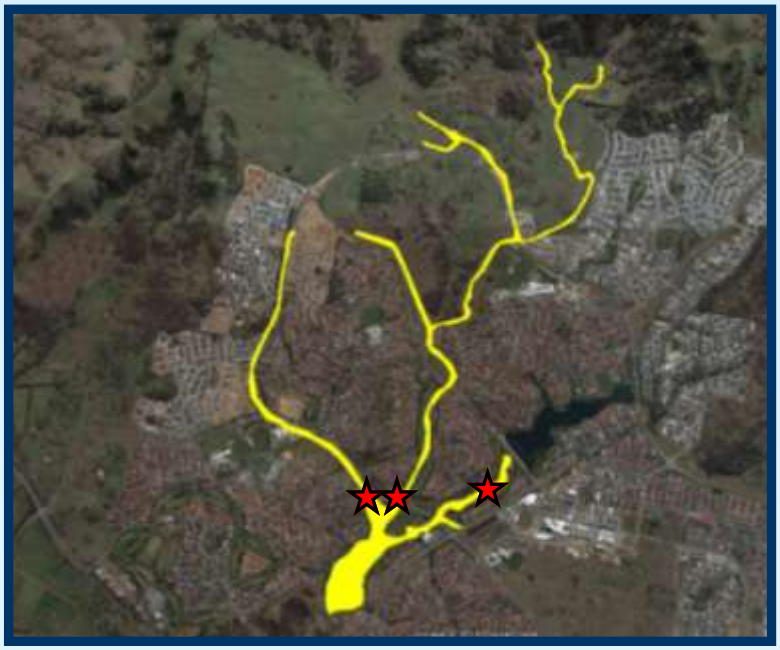
Reach network length: approx. 6 km

Dominant land uses: Urban/Rural Fringe

The north arm of Ginninderra Creek originates in the rural lands surrounding the northern suburbs of Gungahlin and joins the East arm in Gungahlin Pond. The upper reach is mostly ephemeral creeks fragmented by stock dams and flowing to the sediment control pond of Gungahlin. The reach includes a high inflow of urban stormwater from surrounding suburbs and new developing suburbs.

CHIP SUMMARY

From 3 sites there were 17 water quality and 3 waterbug surveys conducted.



Overall the reach water quality results were good. Fair scores from the west arm for Electrical Conductivity (600-800 μS) and Dissolved Oxygen (37-78%) suggest that the construction of Casey is affecting water quality. Turbidity levels were mostly good with only 1 storm event recording 400 NTU; all other recordings below 30 NTU.

The 3 waterbug surveys showed poor results at the inflow sites and fair results for the outflow section. This suggests that whilst habitat value and water quality are relatively poor; water quality does improve through the system. It is also noted that this is a sediment control pond.

OTHER NOTABLE OBSERVATIONS

New development is ongoing within this reach and as a sediment control pond, water quality in Gungahlin Pond will be reduced during this construction phase. Water level fluctuation might improve plant growth and increase the capacity of the wetland to deal with inflow stressors.

Hall Creek (HLC1)

Headwaters to Gooromon Creek

2013/14 CHIP RESULT Data Deficient

REACH FACTS

Reach network length: approx. 10km

Dominant land uses: Urban/Rural Fringe

Starting in the rural lands north of Gungahlin, Hall Creek flows through Hall township and joins Gooromon Creek just north of the suburb of Dunlop in the Grassland reserve. The creek is a mostly ephemeral with intermittent pools and contains sections of moderate erosion with mostly low to moderate habitat value.

CHIP SUMMARY

Monitoring will commence in 2014/15

OTHER NOTABLE OBSERVATIONS

New development in north Gungahlin will impact on the Hall Creek system. 2014/15 monitoring will establish baseline data prior to development.

Yerrabi Pond (YER1)

Headwaters to Dam Wall

2013/14 CHIP RESULT B+

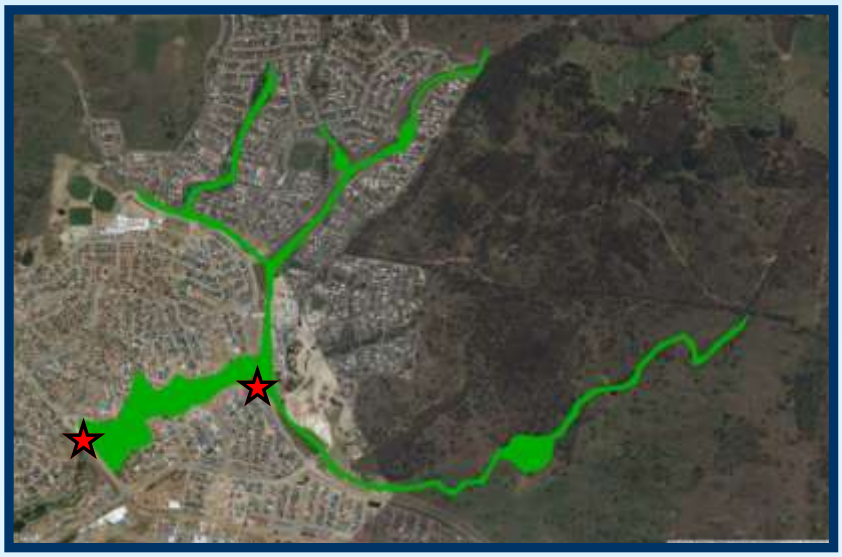
REACH FACTS

Reach network length: approx. 10km

Dominant land uses: Urban/Rural Fringe

The east arm of Ginninderra Creek originates in the rural lands surrounding the northern suburbs of Gungahlin. It includes the former rural lands, now significant woodland reserve, of Mulligans Flat Sanctuary. The upper section is mostly ephemeral creeks fragmented by stock dams and flows into the sediment control pond of Yerrabi. The reach includes a moderate inflow of urban stormwater from surrounding suburbs.

CHIP SUMMARY



From 2 sites there were 10 water quality and 1 waterbug survey conducted.

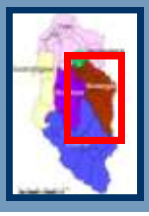
Overall the reach water quality ***results fell within the 'good' range.*** Exceptions being higher than desired pH (8.6) and lower Dissolved Oxygen mostly between 59-89% saturation. Turbidity levels were good with a highest reading of just 29 NTU and mostly below 10 NTU. Electrical Conductivity was moderate with score ranging from 270-490 µS and most likely resulting from recent construction in the area.

The waterbug survey also showed fair results with 8 groups identified mostly from the tolerant to very tolerant categories. The waterbug score is possibly the result of fair salinity and lower habitat value of this urban sediment pond.

OTHER NOTABLE OBSERVATIONS

How Yerrabi Pond copes with constant water levels and accumulated sediment and nutrient levels from the recent construction, will be of interest. Varying water levels to promote plant growth in the pond may be needed for better water quality.

SECTION III: MOLONGLO



CATCHMENT FACTS

The Molonglo catchment extends from the Murrumbidgee River, just downstream of Uriarra Crossing, to the headwaters of Molonglo and Queanbeyan Rivers and Jerrabomberra Creek, an area of about 2,000 km^2

Apart from the urban areas of Queanbeyan and inner Canberra, this diverse catchment includes villages such as Captains Flat, rural residential areas and farmland including Royalla and Carwoola, native and pine forests, wetlands, national parks and the foreshores of Googong Dam, which supplies some of Canberra's and Queanbeyan's water.

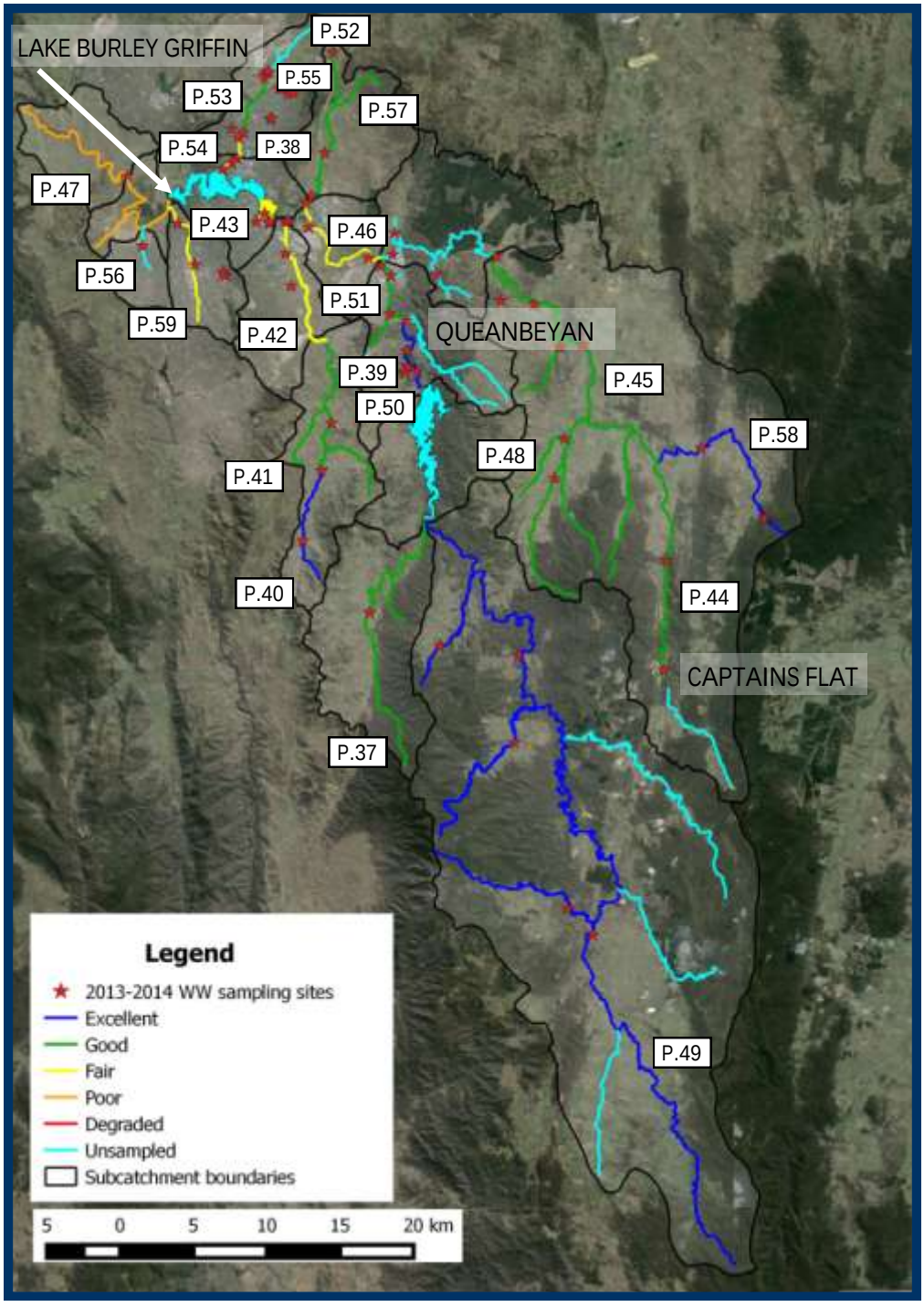
Lake Burley Griffin is on the Molonglo River and collects stormwater and runoff from Queanbeyan as well as much of north Canberra and Woden Creek.

With mostly good water quality in the catchment, the poorest water quality is in the lower Molonglo River, both above and below Lake Burley Griffin, as well as lower Sullivans Creek. Our challenge as a community is to improve water quality as increasing development puts further pressure on these areas. Urban wetlands are one way to achieve this. Education and engagement with urban residents is another important measure.

Railway crossing on Queanbeyan River.

MOLONGLO CATCHMENT HEALTH SUMMARY

Overall, much of the Molonglo Catchment is in excellent or good health (see Map 4), however the combined effects of historic land clearing and urban runoff are very apparent in the lowest parts of the catchment, where catchment health is fair to poor. Water quality data and waterbug results tell a fairly consistent story about the health of individual reaches. A significant challenge is to monitor reaches in the catchment that we currently lack data for such as above Captains Flat on the headwaters of the Molonglo river. Along with broadening our monitoring, this will provide reference points to help better determine the effects of land use practices elsewhere in the catchment. This in turn will help us more effectively address management issues in our waterways.



MAP 4: CHIP results displayed by reaches for the Molonglo catchment. Click on page numbers to see individual reach report cards.

BURRA CREEK (BUR1)

Headwaters to Queanbeyan River

2013/14 CHIP RESULT B-

REACH FACTS

Reach network length: approx. 30km

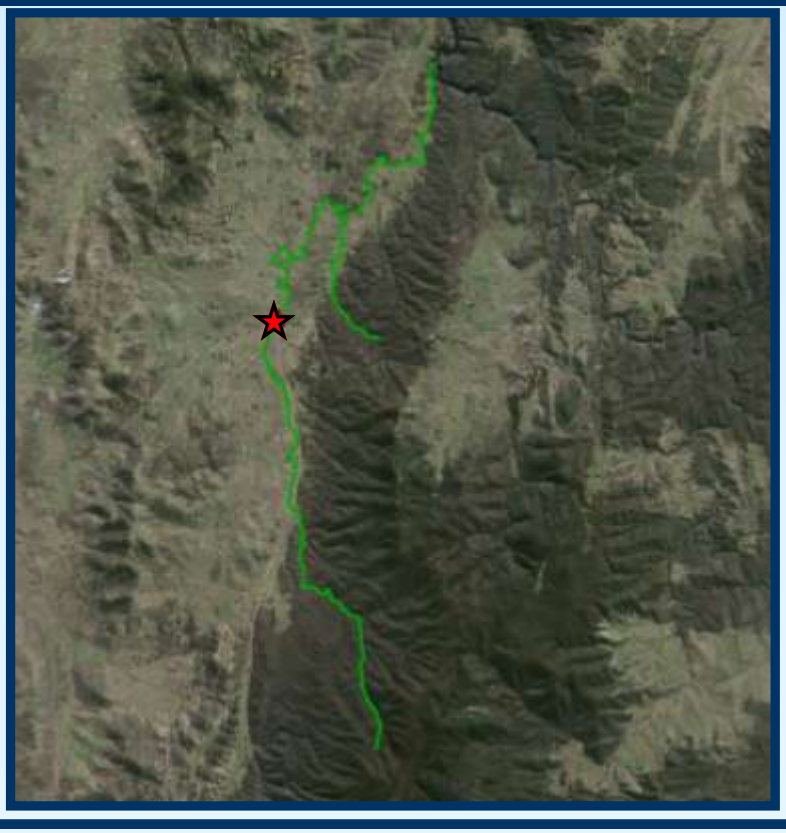
Dominant land uses: Native bush, grazing, rural residential

Burra Creek arises in the north-western edge of the Tinderry Mountains and continues to its confluence with 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. Riparian vegetation is largely absent or dominated by willows, with some reed beds.

CHIP SUMMARY

There were 8 water quality surveys from one site, and one waterbug survey. The site had excellent Total Phosphorus and Nitrates, fair Dissolved Oxygen, poor pH, and Electrical Conductivity (250–630 μS) and Turbidity at degraded levels.

The waterbug score indicated good water quality/habitat. Water at the site tested on this reach may come from the pipeline, which is treated by ACTEW Water before it enters the creek, however the pipeline is not yet operational. It may be interesting to note any changes in water quality when pipeline water enters the creek.



OTHER NOTABLE OBSERVATIONS

A Waterwatch site above the pipeline would improve our knowledge of its impacts.

DICKSON WETLANDS & PONDS (DIC1)

2013/14 CHIP RESULT B+

REACH FACTS

Reach area: approx. 1Ha

Dominant land uses: Urban

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

CHIP SUMMARY

There were 10 water quality surveys from 2 sites, and no waterbug surveys. The reach had excellent Turbidity and Nitrates (N), good Electrical Conductivity and Total Phosphorus, but only had a fair pH, and an extremely poor Dissolved Oxygen (DO - 24–88%).

The slightly elevated pH is normal for artificial wetlands such as this. Low DO at the site generally coincides with increased N. Any available nutrients are likely to be taken up rapidly by algae or bacteria, leading to blooms and then to eutrophication events which deplete DO. Increased nutrients such as N are common in urban runoff.

OTHER NOTABLE OBSERVATIONS

The aerial image above is pre 2011 and does not highlight the extensive planting that has since taken place at Dickson wetlands. Much of this has been undertaken by the volunteers from the Dickson Wetlands Carers group.

GOOGONG CREEK (GGG1)

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: approx. 1km

Dominant land uses: native bush, grazing, rural residential

Googong Creek arises in the new township of Googong, and has its confluence with the Queanbeyan River downstream from the Googong Dam. It flows intermittently (known as an ephemeral creek).

CHIP SUMMARY

There were 11 water quality surveys taken at 2 sites, and no waterbug surveys. Turbidity and Total Phosphorus were excellent, pH and Dissolved Oxygen were good, but Nitrates was only fair (0–15 mg/L), and Electrical Conductivity (EC) indicated a degraded system (250–840 μS).

This is an ephemeral creek which can be associated with high EC readings.

OTHER NOTABLE OBSERVATIONS

The Googong development is likely to have an influence on water quality in this creek. Having a Waterwatch volunteer here is important for monitoring before and after effects.

JERRABOMBERRA CREEK (JER1)

Headwaters to Old Cooma Road

2013/14 CHIP RESULT A

REACH FACTS

Reach network length: approx. 9km

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. It has a number of small creeks flowing into it along this section of the creek. The creek channel has some healthy riparian vegetation before flowing into rural subdivisions where riparian condition is reduced.

CHIP SUMMARY

There were 21 water quality surveys conducted at 2 sites, and no waterbug surveys. The reach had excellent Turbidity, Total Phosphorus and Nitrates, and good pH, but Electrical Conductivity (EC) was only fair (140–590 µS), and there was insufficient data to assess Dissolved Oxygen.

Low flows are common in summer, and the surrounding rock is metamorphic, producing plenty of dissolved minerals. Thus, high EC is not uncommon for this creek.

OTHER NOTABLE OBSERVATIONS

Royalla Landcare have been undertaking revegetation activities for many years. This reach provides a useful reference for the rest of the Jerrabomberra Creek catchment.

JERRABOMBERRA CREEK (JER2)

Old Cooma Road to Jerrabomberra Lake

2013/14 CHIP RESULT B

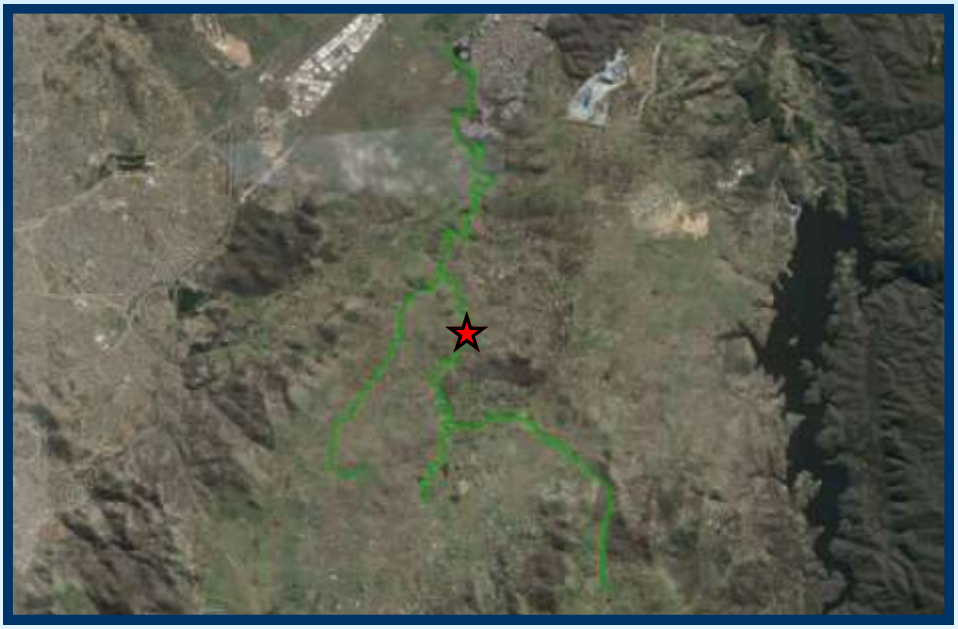
REACH FACTS

Reach network length: approx. 26km

Dominant land uses: Native bush, grazing, rural residential

This section of Jerrabomberra Creek flows through rural subdivisions and has little riparian vegetation. The reach ends at an artificial lake, Jerrabomberra Lake, on the south-western edge of the suburb of Jerrabomberra. This lake also collects stormwater runoff from the suburb before flowing into Jerrabomberra Creek.

CHIP SUMMARY



There were 8 water quality surveys done at one site, and no waterbug surveys. The reach had excellent Nitrates and Turbidity, good Total Phosphorus, but only fair pH (8–8.8). Electrical Conductivity (EC) also indicated a degraded system (180–1020 μS). There was insufficient data to assess Dissolved Oxygen.

A spike of extremely high EC coincided with no flow at the site in late summer. This may be due to the surrounding rock being metamorphic, producing plenty of dissolved minerals that increase EC readings.

OTHER NOTABLE OBSERVATIONS

Fernleigh Park Landcare (now part of Queanbeyan Landcare) have been undertaking revegetation activities for many years.

JERRABOMBERRA CREEK (JER3)

Jerrabomberra Lake to Molonglo River

2013/14 CHIP RESULT C-

REACH FACTS

Reach network length: approx. 11km

Dominant land uses: Rural, light industrial, conservation, recreation, residential

This section of Jerrabomberra Creek flows through Jerrabomberra Grassland Reserve, through some rural land with little riparian vegetation and then through to Jerrabomberra Wetlands. These largely artificial wetlands adjoining the Fyshwick industrial area, capture runoff and stormwater flowing into the creek. The reach also includes the ephemeral Woden Creek. Much of the water in this part reach is backed up and slowed down by Scrivener Dam at the head of Lake Burley Griffin.

CHIP SUMMARY

There were 29 water quality surveys done at 4 sites, and one waterbug survey. Nitrates was excellent, pH was good, but Electrical Conductivity (EC - 240–1650 µS), Turbidity (11–150 NTU), and Dissolved Oxygen (DO - 9–112%) indicated a degraded system. There was insufficient data to assess Total Phosphorus.

Kelly's Swamp is ephemeral and has consistent, extremely high EC and sometimes very low DO, skewing some results for this reach. However, the waterbug survey was done in the creek above the wetlands, and it too indicated poor water quality/habitat.

OTHER NOTABLE OBSERVATIONS

There is some riparian revegetation in the Narrabundah section immediately before Jerrabomberra Wetlands. The entire wetland, but particularly Kelly's Swamp, attracts many birds, with both migratory and resident populations. Platypus and water rats are also seen in this reach.

LAKE BURLEY GRIFFIN, UPPER (LBG1)

2013/14 CHIP RESULT C+

REACH FACTS

Reach area: 1.3 sq km

Dominant land uses: Recreation, urban

Lake Burley Griffin is an artificial lake in the centre of Canberra. It was completed in 1963 after the Molonglo River—which ran between the city centre and Parliamentary Triangle—was dammed. Jerrabomberra Creek and the Molonglo River flow into upper Lake Burley Griffin, as well as pipes and stormwater drains. Pipes and drains include: Telopea Park drain and the Norgrove Park aquatic system at Kingston Foreshore.

CHIP SUMMARY

There were 33 water quality surveys from 3 sites, and no waterbug surveys. Total Phosphorus was excellent, pH and Nitrates were good, but Electrical Conductivity (130–800 µS), Turbidity (9–400 NTU) and Dissolved Oxygen (DO 15–143%) indicated a degraded system.

Any available nutrients are likely to be taken up rapidly by algae and possibly cyanobacteria (commonly called blue-green algae). These sometimes form blooms on Lake Burley Griffin, altering the colour of the water. Such blooms can also lead to eutrophication which may rapidly deplete DO.

OTHER NOTABLE OBSERVATIONS

There is a 5 year, federally-funded project currently underway to improve water quality in the ACT. Areas such as the upper Molonglo and Fyshwick are priority catchments and this should help reduce pollutant loads flowing into Lake Burley Griffin.

MOLONGLO RIVER (MOL2)

Captains Flat to TSR

2013/14 CHIP RESULT B-

REACH FACTS

Reach network length: approx. 10km

Dominant land uses: Grazing, rural residential, mining (historical)

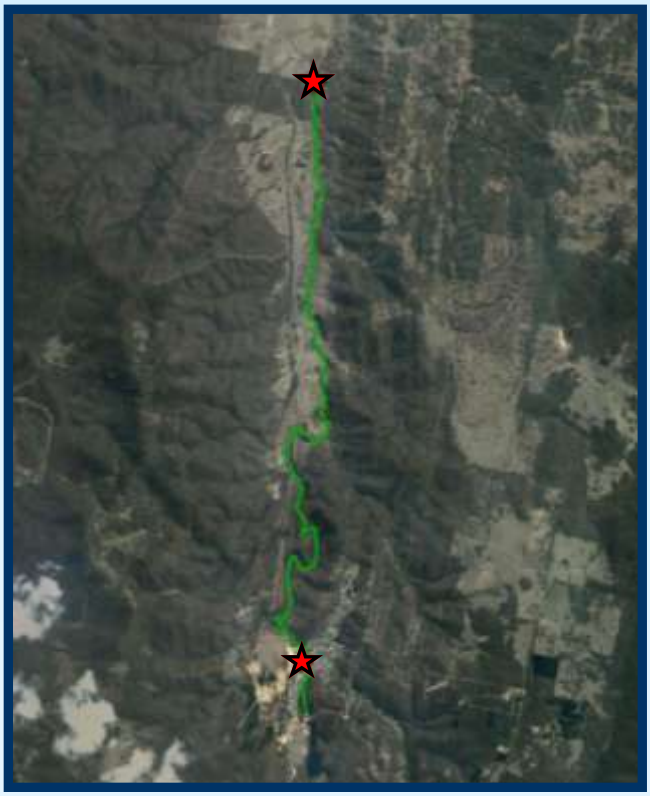
The upstream section of this reach of the Molonglo River begins below the Captains Flat Dam. Leachate from a mine closed in the 1960s continues to contaminate the river with acid minewater and potentially heavy metals. The Molonglo flows through mostly modified rural land and finishes at the Travelling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

CHIP SUMMARY

There were 9 water quality surveys from 1 site, and 3 waterbug surveys from 2 sites. Turbidity and Nitrates were excellent, and pH was good, but Electrical Conductivity (100–300 µS), Total Phosphorus and Dissolved Oxygen (57–83%) were only fair.

The waterbug surveys indicated poor water quality/habitat condition. Environmentally sensitive waterbug orders are detected, however they are represented by species tolerant of the pollution. A reach above the mine may be pursued in 2014/15 as this would prove valuable at gauging the effects of contamination on river health.

Riparian vegetation in this reach varies from poor to moderate. This includes the TSR which has a mix of natives and invasive weeds.



OTHER NOTABLE OBSERVATIONS

Captains Flat Landcare have a project targeting weeds along 6km in the TSR and south towards Captains Flat in the coming year.

MOLONGLO RIVER (MOL3)

DOWNSTREAM OF TRAVELLING STOCK RESERVE NEAR "FOXLOW"

2013/14 CHIP RESULT B

REACH FACTS

Reach network length: approx. 54km

Dominant land uses: Grazing, rural residential

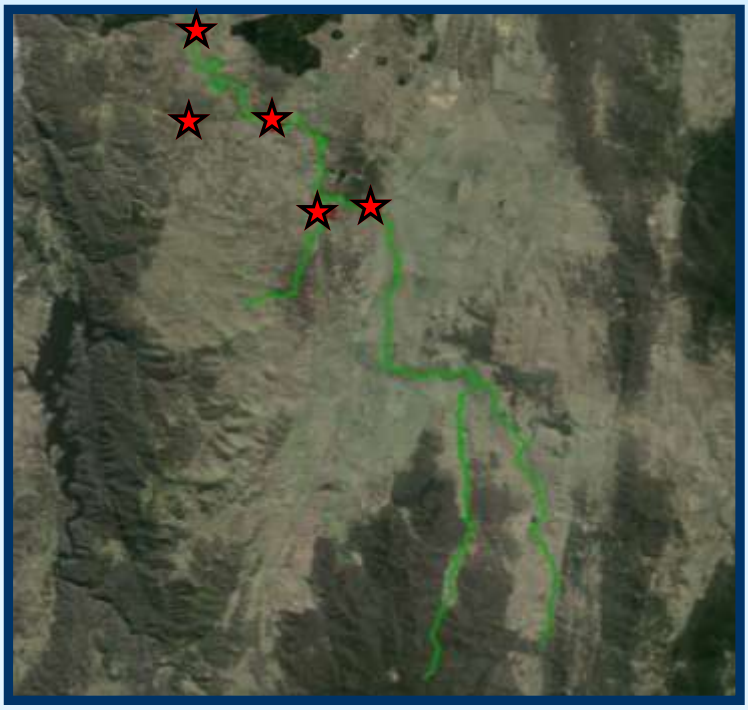
This reach of the Molonglo River extends from below the Travelling Stock Reserve south of "Foxlow" to Burbong Bridge on the Kings Highway and flows through modified rural land and rural subdivisions. The reach includes Plains Creek, Whiskers Creek and Stony Creek, with runoff from the Hoskinstown Plain,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

CHIP SUMMARY

There were 38 water quality surveys from 5 sites, and one waterbug survey. Turbidity, Total Phosphorus and Nitrates were excellent, pH was good, but Electrical Conductivity (EC 160–1330 µS) and Dissolved Oxygen (37–90%) indicated a degraded system.

Stony Creek particularly, but also Whiskers Creek, were the main contributors to the very high EC readings, due to the underlying geology.

The waterbug survey indicated fair water quality/habitat condition. Some river stretches have no riparian vegetation and some are dominated by willows.



OTHER NOTABLE OBSERVATIONS

Hoskinstown Landcare and Carwoola Landcare have been undertaking revegetation work for many years. The Molonglo River Rescue project in 2010-11 focussed on the stretch from Briars Sharrow Road to Burbong.

MOLONGLO RIVER (MOL5)

UPSTREAM OF LAKE BURLEY GRIFFIN

2013/14 CHIP RESULT C+

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 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 before entering Lake Burley Griffin, for which it is the major water source. 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 head of Lake Burley Griffin.

CHIP SUMMARY

There were 33 water quality surveys done at 3 sites, and no waterbug surveys. Nitrates and pH were good, Electrical Conductivity, Total Phosphorus and Dissolved Oxygen was only fair, and Turbidity was indicating a degraded system.

Construction of a major new bridge may have increased Turbidity during this period. Water sports including water skiing take place in this section of the Molonglo River, but has been closed since 2010.

OTHER NOTABLE OBSERVATIONS

Platypus and water rats have often been observed in this section of the Molonglo River.

MOLONGLO RIVER (MOL6)

Lake Burley Griffin to Murrumbidgee River

2013/14 CHIP RESULT D+

REACH FACTS

Reach network length: approx. 26km

Dominant land uses: Urban, grazing, conservation

This section of the Molonglo River extends from immediately below Scrivener Dam on Lake Burley Griffin to the confluence with the Murrumbidgee River, west of Belconnen. It includes the new Molonglo urban development and the Coppins Crossing picnic area.

CHIP SUMMARY

There was no water quality data for this reach, but the one waterbug survey indicated poor water quality.

Water quality in Lake Burley Griffin is recognised as being poor, and riparian vegetation on most of the reach is currently absent, with willows and other introduced species being the dominant vegetation type. There is riparian revegetation planned for this reach in the coming year.

Increased coverage and data are needed for this reach in order to gauge a better picture of catchment health in the lower Molonglo.

OTHER NOTABLE OBSERVATIONS

Impacts are likely to arise from Molonglo urban development, which includes a river corridor park.

PRIMROSE VALLEY CREEK (PRI1)

Headwaters to Molonglo River

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: approx. 34km

Dominant land uses: Conservation, grazing, rural residential

Primrose Valley Creek is a chain of ponds with headwaters in Yanununbeyn 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 Valley Creek is slightly incised. There is little or no riparian vegetation except at the headwaters of Primrose Valley Creek and Antills Creek, and the reach flows through mostly rural land.

CHIP SUMMARY

There were 13 water quality surveys done at 2 sites, and no waterbug surveys. Turbidity, Total Phosphorus & Nitrates were excellent, and pH was good, but Dissolved Oxygen was only fair, and Electrical Conductivity (EC 280–1160 µS) indicated a degraded system.

Although the EC is variable, it is consistently high, and occasionally extreme. High EC was associated with low flows in these ephemeral streams, particularly when it coincided with high evaporation over warmer months. This often results from the geology and hydrology of the local area.

OTHER NOTABLE OBSERVATIONS

Mountain galaxias (a small native fish) has been recently observed in this river catchment.

QUEANBEYAN RIVER (QUE1)

UPSTREAM OF GOOGONG DAM

2013/14 CHIP RESULT A-

REACH FACTS

Reach network length: approx. 143km

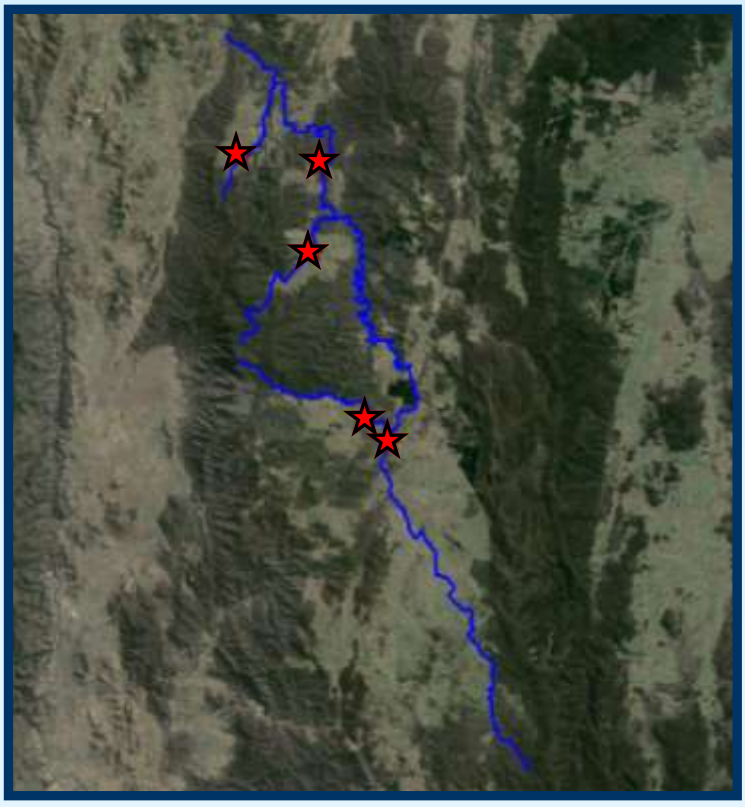
Dominant land uses: Conservation, grazing, rural residential

The upper section of the Queanbeyan River is a extensive stretch of river that runs from its origins on the southern slopes of the western Tinderry Ranges to the Googong Dam. The reach includes Sherlock Creek, Urialla Creek, Tinderry Creek, Roberts Creek and Bradleys Creek.

CHIP SUMMARY

There were 50 water quality surveys done at 5 sites in the reach, and 2 waterbug surveys. Turbidity and Nitrates were excellent, pH, Electrical Conductivity and Total Phosphorus were good, but Dissolved Oxygen was only fair. The waterbug score indicated good water quality.

Riparian vegetation varies from relatively intact native riparian vegetation within steep sided valleys to absent or poor riparian vegetation on cleared rural land in less rugged country.



OTHER NOTABLE OBSERVATIONS

This is a particularly long reach and an increase in waterwatch sites would enable the development of more reaches and a better indication of change across this catchment.

QUEANBEYAN RIVER (QUE2)

DOWNSTREAM OF GOOGONG DAM TO CITY OF QUEANBEYAN

2013/14 CHIP RESULT A-

REACH FACTS

Reach network length: approx. 6.7km

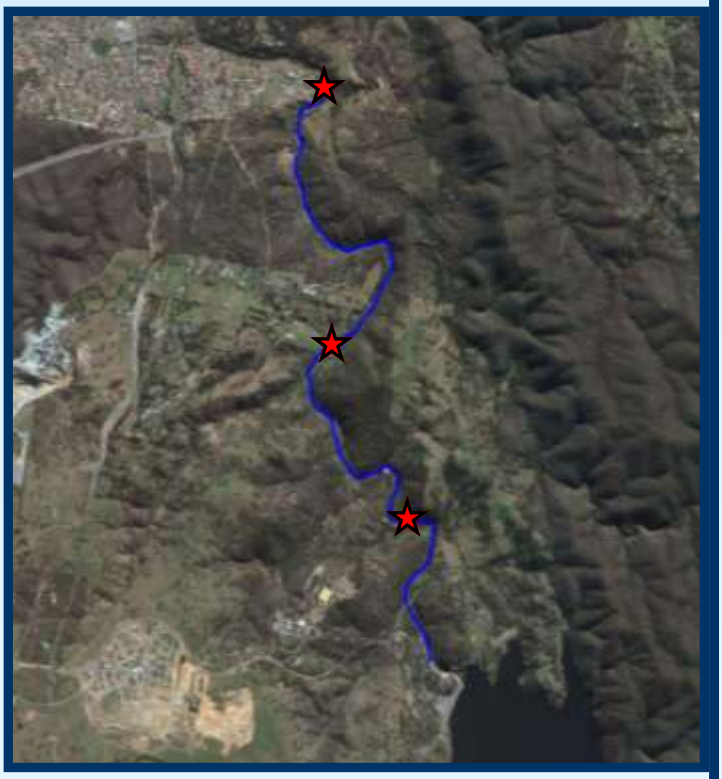
Dominant land uses: Urban, rural residential

This section of the Queanbeyan River extends downstream from Googong Dam to the edge of Queanbeyan city. It includes Googong, Montgomery and Gorge Creeks near the Googong township, and Valley Creek flowing out of Cuumbuen Nature Reserve.

CHIP SUMMARY

There were 14 water quality surveys done at 3 sites in the reach, and 3 waterbug surveys. Turbidity, Total Phosphorus and Nitrates were excellent, Electrical Conductivity and Dissolved Oxygen were good, but pH was only fair (7–8.7). The waterbug score indicated good water quality.

Riparian vegetation was previously dominated by willows which have since been removed by Queanbeyan Council as part of a long term river management plan.



OTHER NOTABLE OBSERVATIONS

This reach could potentially be impacted by the new township of Googong and associated infrastructure. Platypus are regularly sighted in this reach.

QUEANBEYAN RIVER (QUE3)

QUEANBEYAN CITY TO CONFLUENCE WITH MOLONGLO RIVER

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: approx. 9.4km

Dominant land uses: Urban

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

CHIP SUMMARY

There were 10 water quality surveys done at 2 sites in the reach, and 1 waterbug survey from an additional site. Turbidity was excellent, Electrical Conductivity, Total Phosphorus, Dissolved Oxygen and Nitrates were good, but pH was poor (7.2 –10). There is no obvious cause for the high pH so this requires investigation.

The waterbug survey indicated good water quality. Riparian vegetation in this reach is progressively improving following willow removal by Queanbeyan Council.

There is potential for an impact on water quality from the construction of the Ellerton Drive Extension, particularly on Barracks Creek which has poor water quality but contributes only a small volume of the water in Queanbeyan River.

OTHER NOTABLE OBSERVATIONS

This section of the Queanbeyan River supports a healthy population of platypus.

SULLIVANS CREEK, UPPER (SUL1)

2013/14 CHIP RESULT Data Deficient

REACH FACTS

Reach network length: approx. 6km

Dominant land uses: Conservation, grazing (historical), industrial

Sullivans Creek originates in Goorooyarroo Nature Reserve, flows through historical grazing land then into a concrete channel. It then flows through the new suburb of Kenny, west of Watson, and adjoins the industrial area of Mitchell before flowing into a constructed wetland that was built in 2009.

CHIP SUMMARY

This section of Sullivans Creek is ephemeral and some sites were often dry. Despite water quality being sampled or observed 9 times at 3 different sites over the period, there were no waterbug surveys, and there was insufficient data to calculate a CHIP score. It is not possible to infer anything about water quality in this reach over this period.

OTHER NOTABLE OBSERVATIONS

The lower section of this catchment was affected by a chemical fire at Mitchell in 2011. The constructed wetland has limited the impacts further downstream.

SULLIVANS CREEK (SUL2)

Flemington Road to ANU

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: 4.5km

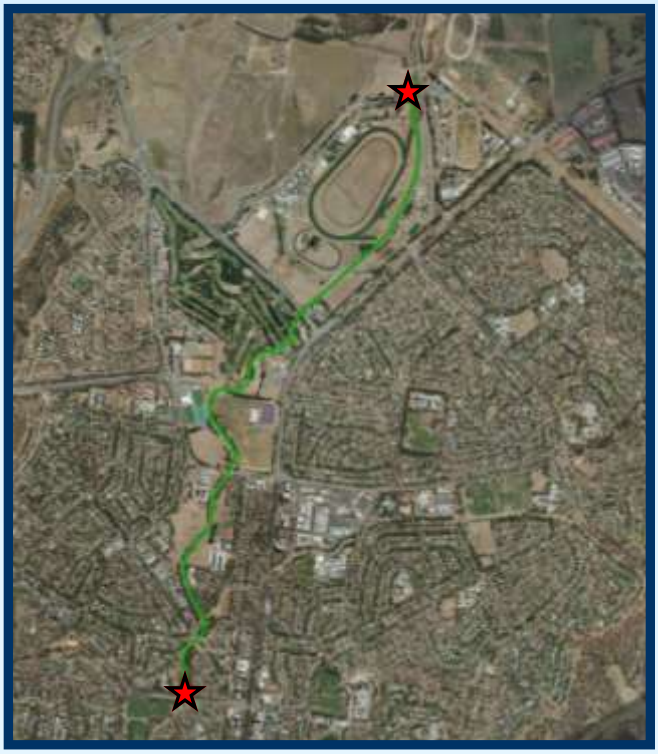
Dominant land uses: Urban, recreation

After passing under Flemington road, the middle Sullivans Creek reach continues to flow in a concrete channel before flowing into Flemington Pond. The reach is crossed by some major roads and adjoins the Yowani golf course. The two waterbodies at the golf course overflow into Sullivans Creek during high rainfall events. The reach then receives waters from the Lyneham constructed wetlands towards the bottom of the reach and ends just *above the O'Connor playing fields.*

CHIP SUMMARY

There were 6 water quality surveys done at 2 sites in this reach, and one waterbug survey. Water quality data was deficient for many parameters, but Turbidity was excellent, and Electrical Conductivity was good. Limited data suggests that pH may be high in this reach.

The waterbug survey indicated poor water quality, poor riparian habitat or both.



OTHER NOTABLE OBSERVATIONS

Additional sampling in this reach is required to improve confidence in these results.

SULLIVANS CREEK, ANU (SUL3)

2013/14 CHIP RESULT C

REACH FACTS

Reach network length: approx. 3.7km

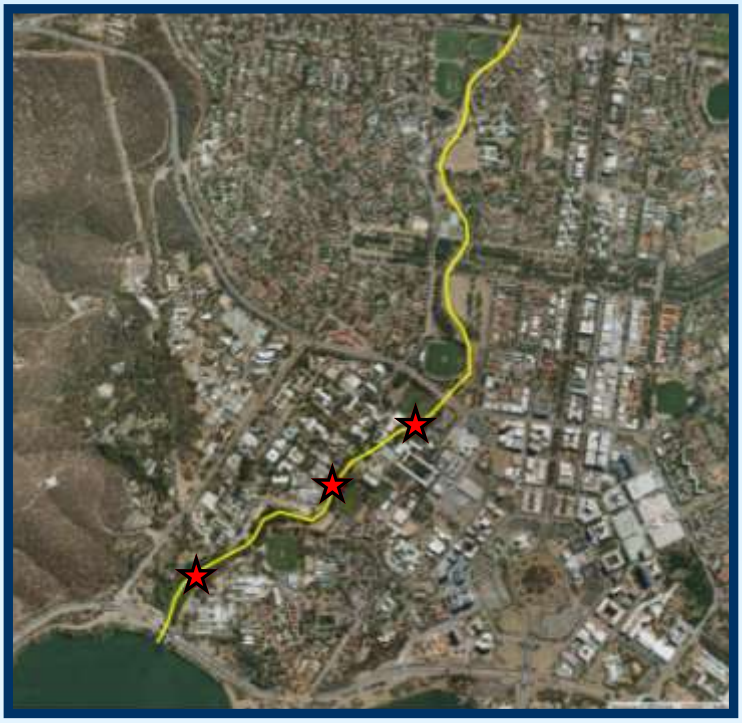
Dominant land uses: Urban, recreation

This section of Sullivans Creek flows in a concrete channel through playing fields and parklands in O'Connor and Turner, crossed by many minor roads, before entering ANU campus. It passes through the Barry Drive gross pollution trap and Toad Hall pond, before continuing, in part in a concrete channel through the ANU before flowing into Lake Burley Griffin.

CHIP SUMMARY

There were 30 water quality surveys taken at 3 sites, and 3 waterbug surveys. Turbidity was excellent, pH was good, Electrical Conductivity was fair, but Total Phosphorus (0–3.02 mg/L) and limited Dissolved Oxygen data indicated a degraded system (32–53%). The waterbug surveys also indicated poor water quality/habitat.

This reach has some of the poorest water quality in the Molonglo catchment. This is largely due to the runoff from Canberra City itself, since most of the other drainage lines that contribute water to Sullivans Creek pass through urban wetlands, which are generally effective in improving water quality.



OTHER NOTABLE OBSERVATIONS

Waterbugs at the 3 sites suggest poor water quality and poor habitat, and reflect the poor water quality results and limited riparian vegetation along this reach.

WATSON WETLANDS AND PONDS (WAT1)

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: approx. 1.4Km

Dominant land uses: Conservation, urban

Watson wetlands and ponds on the lower western slopes of Mt Majura comprise several dams which overflow during high rainfall into Watson constructed wetlands and from there via pipes flows into Sullivans Creek.

CHIP SUMMARY

From 4 sites there were 20 water quality surveys conducted, with no waterbug surveys. Water quality was generally good, however there were several surveys with very low Dissolved Oxygen (18–108%) and high Turbidity (10–150 NTU).

The dams frequently have low or no flow and sometimes dry up, which probably accounts for the low dissolved oxygen. Nitrates and phosphates were low, and these low levels of nutrients generally kept algae abundance low.

OTHER NOTABLE OBSERVATIONS

The ephemeral nature of some of these ponds means that while gambusia (mosquito fish) can be a problem, they cannot persist in the ponds that dry out. This makes those ponds important refuges for frogs as their tadpoles and eggs often are predated on by gambusia.

WESTON CREEK (WES1)

2013/14 CHIP RESULT Data Deficient

REACH FACTS

Reach network length: approx. 6.7km

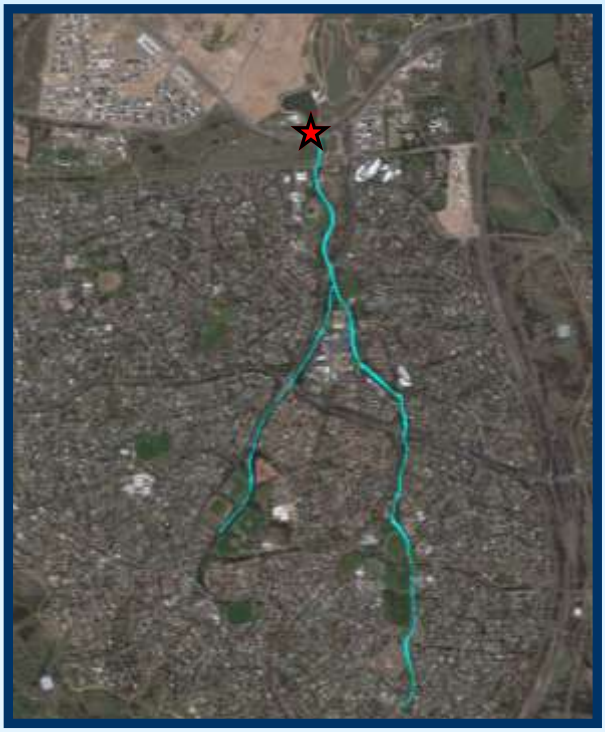
Dominant land uses: Urban

Weston Creek 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 south-east of the new Molonglo development. It then passes close to the new Molonglo development's eastern side and on to its confluence with the Molonglo River below Lake Burley Griffin.

CHIP SUMMARY

Despite water quality being sampled 7 times at one site, there were no waterbug surveys, and there was insufficient data to calculate a CHIP score from a single site.

Data was collected fairly consistently at one site, and indicated poor water quality or a degraded system on most measures most of the time. This is not unexpected in a reach with water comprised almost entirely of suburban runoff, where the water flows in a concrete channel and riparian vegetation is very limited.



OTHER NOTABLE OBSERVATIONS

Water quality was surveyed at the sampling site until access to the site was closed during construction. Efforts to gather more data for this reach, including waterbug sampling, would prove very valuable.

WOOLSHED CREEK (WOO1)

2013/14 CHIP RESULT B+

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 at the top of the catchment. It flows through highly modified rural land with some native riparian vegetation in the higher section and some significant waterholes. Two short sections of the creek were moved to make way for Majura Parkway, and the creek joins the Molonglo River near Fairbairn Avenue, just upstream of Lake Burley Griffin.

CHIP SUMMARY

From 3 sites there were 21 water quality surveys conducted for this reach, and one waterbug survey. Turbidity and Total Phosphorus were excellent, and pH and Nitrates were good, but Electrical Conductivity (EC) and Dissolved Oxygen indicated a degraded catchment.

High EC readings at the middle site (620–2000 µS) on the reach are believed to be influenced by groundwater entering near the site. A recent hydro-geological survey will improve knowledge of this reach.

The waterbug survey indicated good water quality/habitat.

OTHER NOTABLE OBSERVATIONS

It is an ephemeral stream with frequent periods of no flow but the waterholes along this reach are important habitat. Involvement with ACT Roads may result in further riparian plantings and other catchment improvements along the reach over the next year.

YANDYGUINULA CREEK (YAN1)

2013/14 CHIP RESULT A-

REACH FACTS

Reach network length: approx. 18km

Dominant land uses: native bush, grazing, wetlands

Yandyguinula Creek is a tributary of the Molonglo River, with the confluence on "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, it passes through an extensive wetland area which supports a significant bird population.

CHIP SUMMARY

From 2 sites there were 20 water quality surveys conducted for this reach, with no waterbug surveys. pH, Electrical Conductivity, turbidity and N were all excellent, but Dissolved Oxygen (37–86%) was only fair, and Total Phosphorus was poor (0–1 mg/L).

Elevated Total Phosphorus is likely to be caused by stock accessing the creek and the many birds in the wetlands.

OTHER NOTABLE OBSERVATIONS

At times this creek can stop flowing during periods of low rainfall.

YARRALUMLA CREEK (YAR1)

2013/14 CHIP RESULT C+

REACH FACTS

Reach network length: approx. 9km

Dominant land uses: Conservation, urban

This is one of two main creek systems draining into the Molonglo River below Scrivener Dam. Yarralumla Creek includes three drain lines, one along the west side of Mt Mugga Mugga, one from Farrer to Phillip, and one from Long Gully to Garran. These drain lines run largely in concrete channels. Yarralumla Creek then runs parallel with Curtin in a concrete stormwater channel then down through a deeply incised channel to the Molonglo River immediately below Scrivener Dam.

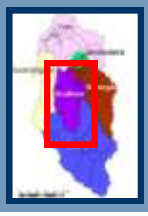
CHIP SUMMARY

From 4 sites there were 42 water quality surveys conducted for this reach, and 1 waterbug survey. Although N was excellent and pH was good, Total Phosphorus was only fair, and Electrical Conductivity (220–920 µS), Turbidity (9–100 NTU) and Dissolved Oxygen (11–153%) all indicated a degraded system. The waterbug survey indicated poor water quality/habitat. This creek, from several drainage lines, collects runoff from a large urban area.

OTHER NOTABLE OBSERVATIONS

This site is ~100m below a gross pollution trap, and has cigarette butts and rubbish. There is sometimes a bad smell noted by the Waterwatcher at this site.

SECTION IV: SOUTHERN ACT



CATCHMENT FACTS

For the purpose of the CHIP report, the Southern ACT area is divided into sub-catchments based around 5 main rivers in the region.

- Murrumbidgee River
- Naas River
- Gudgenby River
- Cotter River
- Paddy's River
- Tuggeranong Creek

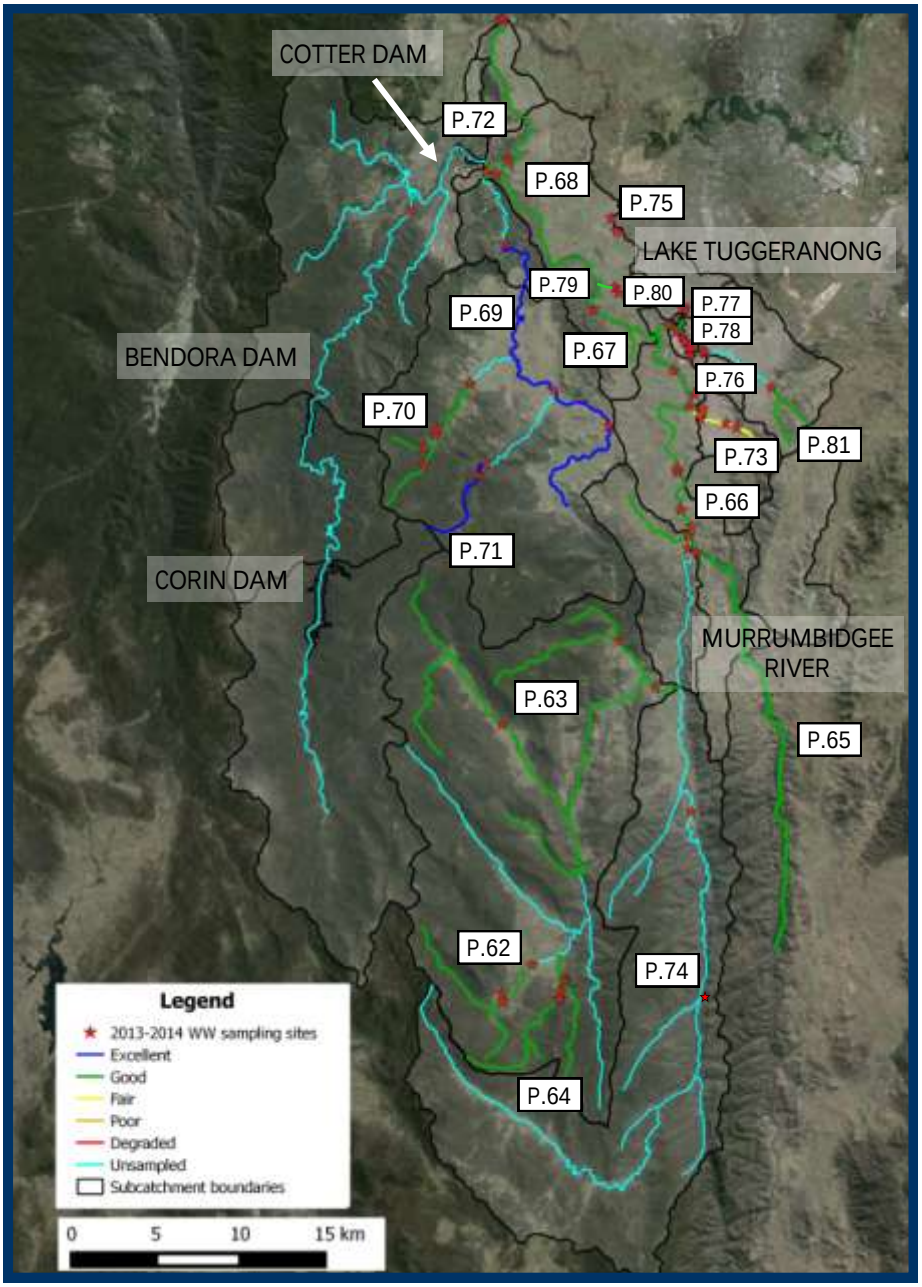
The Naas and the Gudgenby river systems are the highest in the ACT and originate in the mountains of the Namadji National Park. The Cotter River provides our main drinking supply and flows north adjacent to the Brindabella Ranges. Paddy's River is a smaller rural water way flowing to the west of the Bullen Range past forestry land and grazing properties to the immediate west of Canberra. Tuggeranong Creek is our predominately urban waterway flowing from the east of the ACT into Lake Tuggeranong. Most of this system is engineered with pipes and concrete channels. All of these waterways join the Murrumbidgee River in the ACT which flows north from Angle Crossing near Tharwa to Uriarra Crossing just before the Molonglo River confluence.

The Murrumbidgee River at Casuarina Sands, June 2013.

SOUTHERN ACT CATCHMENT HEALTH SUMMARY

The landscape covered by the Southern ACT catchment reaches has enjoyed relative good catchment health this period with reaches ranging from 'fair' to 'excellent' (see Map 5). This is most likely a result of the reasonable rainfall it has experienced since 2010. Drought conditions with high temperatures and local fires followed by extreme downpours are the biggest drivers behind deteriorating catchment health in this region. Fortunately we have been spared the effect of these for the past few years.

In general the waterways of the Southern ACT enjoyed good water quality scores. The exceptions were some of the urban reaches the which suffered significant blue-green algal blooms this period. Some rural dams also appeared to suffer the effects of persistent high nutrient levels. The urban lake systems are becoming eutrophic and extremely low levels of dissolved oxygen and high nutrient level readings are not uncommon.



MAP 5: CHIP results displayed by reaches for the Southern ACT catchment. Click on page numbers to see individual reach report cards.

Bogong Creek catchment (CGB1)

2013/14 CHIP RESULT B

REACH FACTS

Reach network length: 13Km

Dominant land uses: Conservation

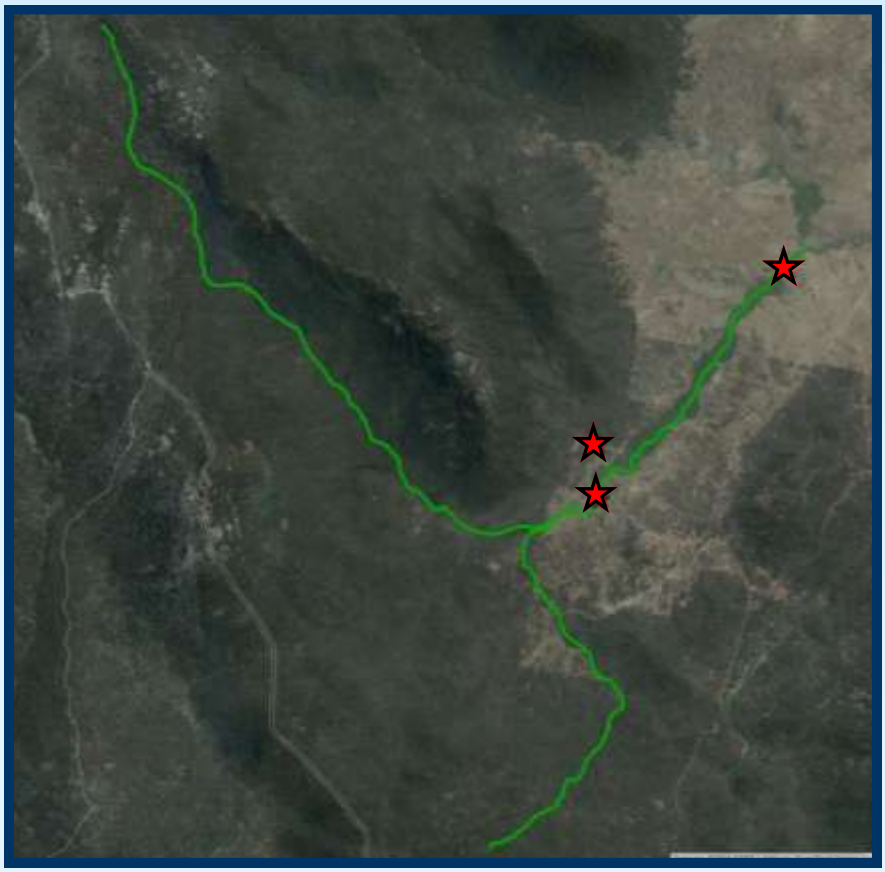
Part of the Gudgenby River catchment. At its lowest end Bogong Creek is a wide and mostly treeless upland creek/bog flowing north east in the middle of Namadji National Park.

CHIP SUMMARY

Three monitoring sites with 18 water quality surveys were used to produce this CHIP score in addition to a waterbug survey at the lowest site near Yankee hat bridge.

Low Dissolved Oxygen (31–82%) readings are common in the boggy lower sections of this creek. Likewise Total Phosphorus levels were fair.

The upper creek lines are extremely narrow for most of their length. They have a healthy canopy cover and this delivers cool clear water to the lower reach where the monitoring occurs.



OTHER NOTABLE OBSERVATIONS

Much of the area was pine forest until 2003 when the region was comprehensively burnt out.

Gudgenby River catchment (CGG1)

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: 22.7Km

Dominant land uses: Conservation and rural grazing

This reach includes 3 branches. The main arm is the lower stretch of Gudgenby River, running mostly through rural cattle grazing properties. The Honey Suckle Creek arm runs adjacent to Apollo Road which heads up to the old Honey Suckle Creek Tracking Station site next to Namadji National Park. The creek is mostly surrounded by healthy wooded vegetation.

CHIP SUMMARY

3 monitoring sites with 31 water quality surveys were used to produce this CHIP score.

Turbidity was excellent during this census period, conversely Total Phosphorus levels were fair. Low Dissolved Oxygen and high nutrient levels can be a concern at the downstream sites in the hot seasons due to low water levels, stock using the river and absent riparian canopy. Upstream sites do not suffer as badly.

Honey Suckle Creek and Orroral River monitoring is limited to Electrical Conductivity, pH and Turbidity readings. A modified monitoring program established for Outward Bound needed an absence of complex chemical techniques.

OTHER NOTABLE OBSERVATIONS

The Orroral River arm comprises mostly of upland bog flats and flows past the old Orroral River tracking station site. Both tracking stations were decommissioned in the early 1980's.

Hospital Creek catchment (CGH1)

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: Hospital Creek arm (on the left) 12Km, Little Dry Creek arm (on right) 7Km

Dominant land uses: Conservation

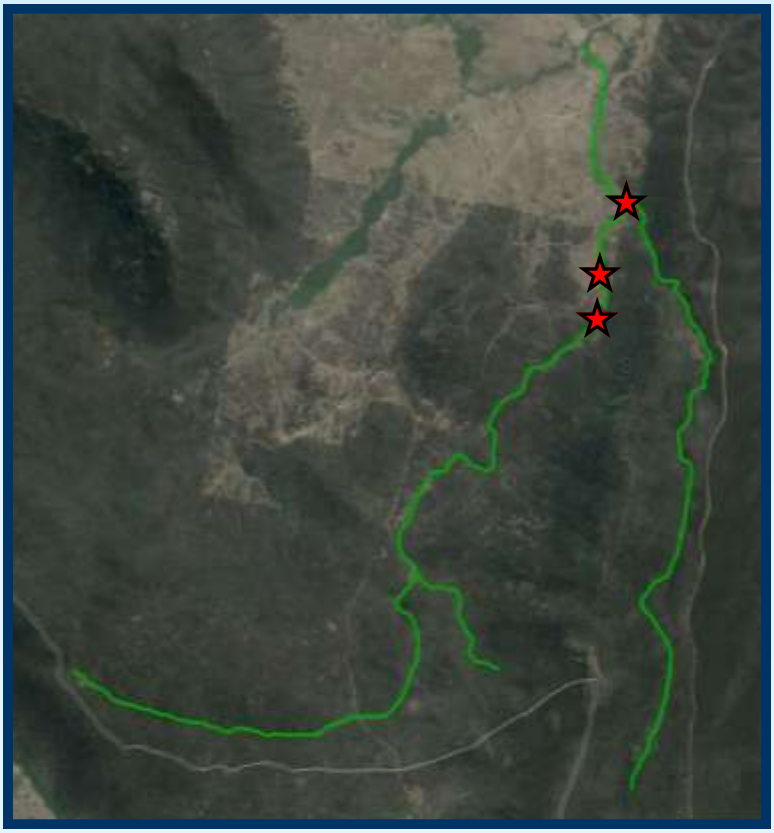
Hospital Creek is mostly a forested gully south and parallel to Bogong Creek. It turns north forming an upland bog before joining Bogong Creek. Little Dry Creek is an ephemeral arm to the east of Hospital Creek.

CHIP SUMMARY

Three monitoring sites with 22 water quality surveys were used to produce this CHIP score as well as a waterbug survey conducted at Little Dry Creek site in autumn 2014.

Fair Dissolved Oxygen levels and moderately high Total Phosphorous loads are common occurrences in these boggy water ways. Extreme Total Phosphorous spikes have been studied by the ANU and proven to occur through natural decomposition of local algae.

The sites in this reach are monitored every second month due their remote location. Frogs and aquatic insects are regularly heard/observed at these sites.



OTHER NOTABLE OBSERVATIONS

Little Dry creek is often the first in Southern ACT to dry up in low rain fall periods. This last happened in 2010 at the end of the last drought.

Murrumbidgee River (CMM6)

Willows Rd to Tharwa 'Sandwash'

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: approx. 22 km

Dominant land uses: Rural grazing, rural residential and conservation

This stretch of the Murrumbidgee River begins at Willows Rd in NSW and includes Angle Crossing on the ACT/NSW border. It runs through the Gigerline Gorge Reserve in the ***ACT and ends at Tharwa 'Sandwash'. Recreational fishing is banned in the ACT stretch*** of this reach and the riparian vegetation is significantly healthier than downstream around the Tharwa township.

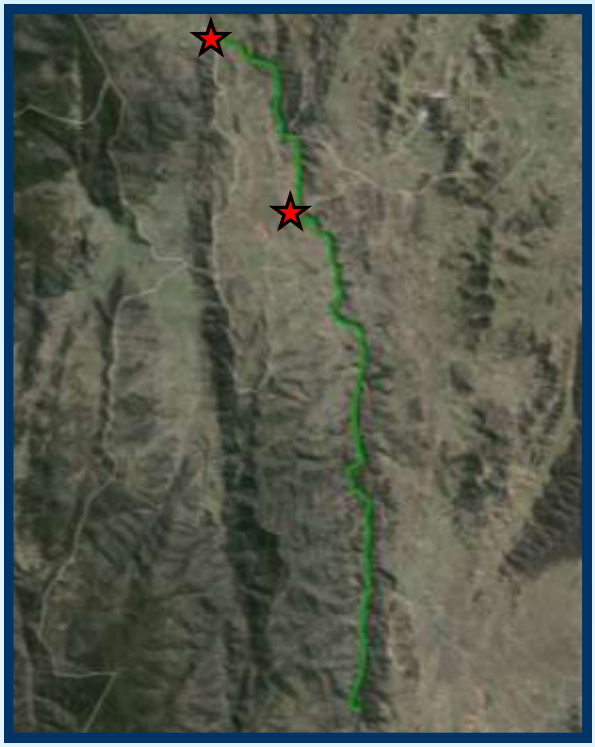
CHIP SUMMARY

Two monitoring sites with 14 water quality surveys were used to produce this CHIP score.

Total Phosphorus readings were rated fair quality, while all other water quality parameters were good or excellent.

With the exception of Angle Crossing and Tharwa ***'Sandwash', the reach consists of bedrock*** dominated gorge country. While Gigerline Reserve has fairly intact riparian condition, woody weeds are more of an issue on the NSW component of the reach. Stock are not able to access this gorge county but could be using the tributary gullies. This may be the source of the Total Phosphorus loads.

Unfortunately, not all records for Angle Crossing made it into this CHIP score for 2013/14.



OTHER NOTABLE OBSERVATIONS

Angle Crossing is the southern most point of the Murrumbidgee River in the ACT. ACTEW Water have extraction facilities to draw water from Angle crossing and pump it to Googong dam.

Murrumbidgee River (CMM7)

Tharwa 'Sandwash' to Point Hut Crossing

2013/14 CHIP RESULT B

REACH FACTS

Reach network length: approx. 14km

Dominant land uses: Rural grazing

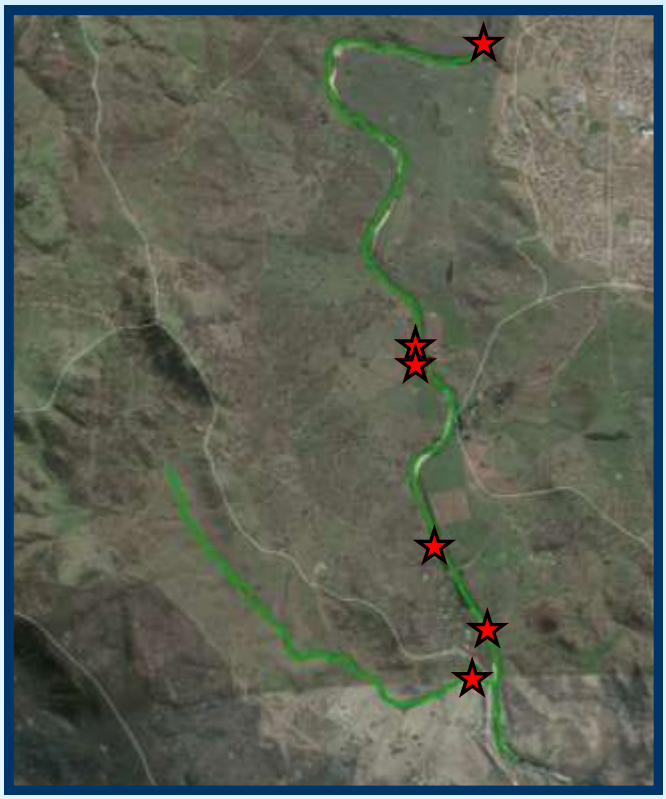
This reach covers the stretch of Murrumbidgee River from Tharwa 'Sandwash' to Point Hut Crossing next to the Canberra suburb of Gordon. The riparian vegetation is this reach is extremely poor with very little mature canopy species. The shallow gradient of this section also compounds the problem of sediment build up, which reduces in-stream habitat.

CHIP SUMMARY

Six monitoring sites with 44 water quality surveys were used to produce this CHIP score. In addition, 1 waterbug survey was conducted at Point Hut crossing in autumn 2014.

Slightly elevated pH and Turbidity during peak flows are common in this reach. High Total Phosphorus readings (0.01–2 mg/L) were also observed during sampling. Historically, this section of the Murrumbidgee River has scored poorly in assessments of riparian condition due to lack of canopy. In spite of this, good rainfall appears to have improved the overall rating of this reach.

Engineered log/rock structures have been put in place by ACT Conservation Planning and Research to facilitate water gouging to move sediment downstream, and provide habitat connectivity for native fish.



OTHER NOTABLE OBSERVATIONS

Most monitoring in this reach is conducted by local land owners/residents on their properties. Revegetation projects have begun this year at properties along the reach.

Murrumbidgee River (CMM8)

Point Hut Crossing to Kambah Pool

2013/14 CHIP RESULT B

REACH FACTS

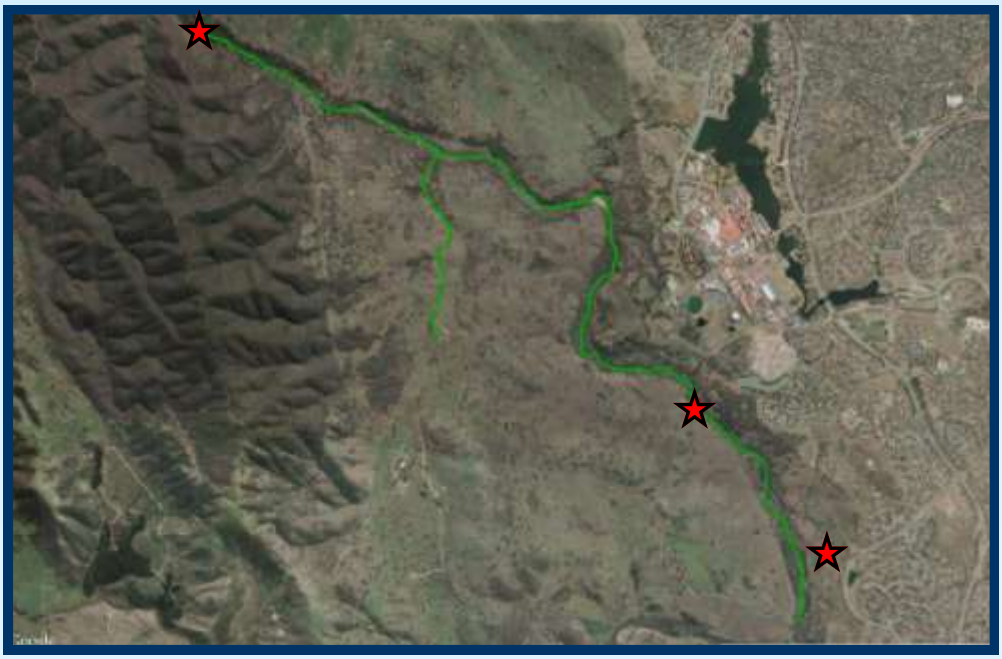
Reach network length: approx. 23km

Dominant land uses: Urban, conservation and recreation

This reach covers the section of Murrumbidgee River from Point Hut Crossing to Kambah Pools and includes Pine Island reserve. All three spots are popular recreational sites. Red Rock Gorge and the confluence with Tuggeranong Creek are also within this reach.

CHIP SUMMARY

Three monitoring sites generating 32 water quality data surveys were used to produced this CHIP score, plus 1 waterbug survey at Pine Island in autumn 2014.



Fair pH and Dissolved Oxygen readings are common along this stretch of the Murrumbidgee River. A poor waterbug score is due to low species richness. These issues could be a product of the urban inflows in this section of the Murrumbidgee.

Erosion and revegetation work has been conducted by an active Parkcare group between ***Point Hut Crossing and Pine Island, as well as along Barney's Gully.***

OTHER NOTABLE OBSERVATIONS

A Waterwatch site is on Barney's Gully, an ephemeral creek, off Woodcock Dr Gordon. This creek usually has flowing water as a result of connection to suburban stormwater system in Gordon.

Murrumbidgee River (CMM9)

Kambah Pools to Uriarra Crossing

2013/14 CHIP RESULT B

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 this reach flows past old pine forest plantations and areas still used for grazing and farming. The reach includes the small swamp Creek, an ephemeral creek running past Uriarra Homestead into Murrumbidgee river at Uriarra Crossing.

CHIP SUMMARY

Three monitoring sites generating 27 water quality surveys were used to produce this CHIP score, plus 1 autumn waterbug survey from Casuarina Sands which occurs just downstream of the confluence with the Cotter River.

High Total Phosphorus (TP) readings are common at Casuarina Sands. The ***site also scored 'poor' for waterbugs*** showing a low diversity of tolerant species. This may be influenced by the above mentioned TP readings.

Generally though, this reach has responded favourably to the good rainfall of the past 3 years and this shows in the overall CHIP result.

OTHER NOTABLE OBSERVATIONS

This reach also forms the culmination of 3 large river systems, the Murrumbidgee, Paddy's and Cotter with some significant variation in their respective land uses.

Paddy's River Upper (CTP1)

2013/14 CHIP RESULT A-

REACH FACTS

Reach network length: approx. 24km

Dominant land uses: Rural grazing

Paddy's River runs mostly through active grazing properties and softwood plantations. This reach covers the section below the headwaters high up in Mt Tennant in the Namadgi National Park. The river has been subject to massive erosion through large flooding events in recent years.

CHIP SUMMARY

Three monitoring sites with 23 water quality surveys were used to produce this CHIP score in addition to the water bug survey at ***Murray's Corner in autumn 2014.***

Turbidity readings (9–270 NTU) are often high after rain events. This also drives down the Dissolved Oxygen levels. Total Phosphorus and Nitrate levels are excellent in this reach.

The river is very shallow along much of its length making it very susceptible to minor changes in rainfall. The water quality was nonetheless excellent during this census period.

OTHER NOTABLE OBSERVATIONS

A large section of this reach is on Booroomba Homestead, which suffered major earth slips in the floods of 2011. The upper part of the river still carries a lot of mobile sand and soil as a result.

Tidbinbilla River (CTT1)

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: 8.5Km

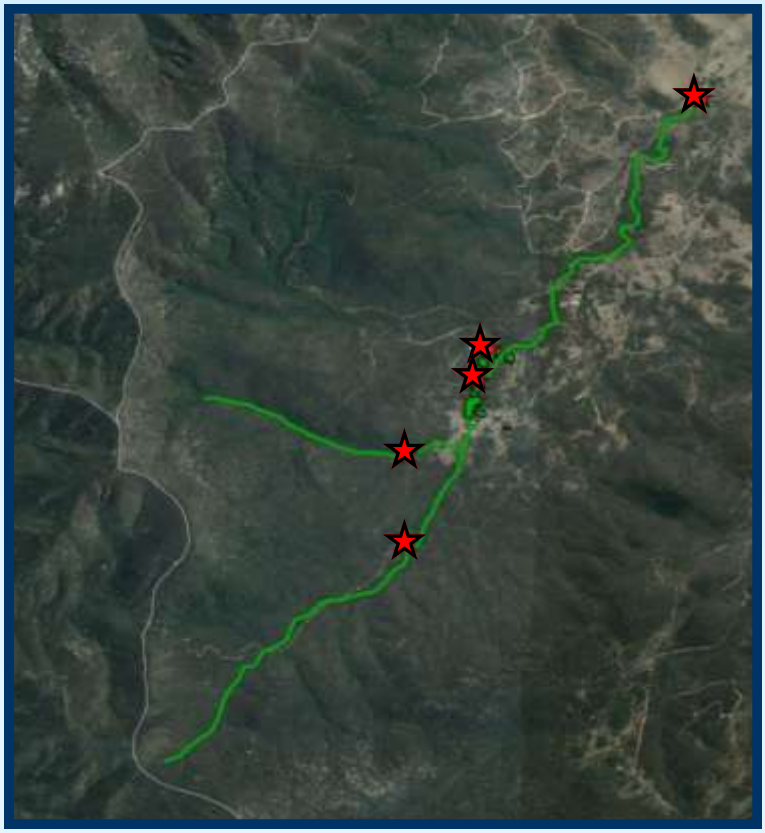
Dominant land uses: Conservation and rural grazing

This reach covers most of the Tidbinbilla River and the adjacent artificial wetlands (the Sanctuary). Most of the river is in the Tidbinbilla Nature Reserve and has significantly recovered from a catastrophic bush fire 11 years ago. Ashbrook Creek is a small upland creek running from the top of the reserve past the Hanging Rock Aboriginal shelter site.

CHIP SUMMARY

Five monitoring sites with 47 water quality surveys were used to produce this CHIP score. In addition, 2 water bug surveys were conducted in autumn 2014 - one at the top site on the Tidbinbilla River and another at the Ashbrook Creek site.

High Turbidity (9–46 NTU) and low Dissolved Oxygen (27–106%) can be a concern in the Sanctuary. The ponds of the Sanctuary are fed by a diversion in the Tidbinbilla River. The water flows through 5 ponds before being returned. Generally the water quality in this reach is good, however it is very susceptible to dry conditions, being a very small and shallow river system.



OTHER NOTABLE OBSERVATIONS

The lower section flows past the working cattle and sheep property Tidbinbilla Station, which can suffer significant erosion in high flow events.

Gibraltar Creek (GIB1)

2013/14 CHIP RESULT A

REACH FACTS

Reach network length: 8.5Km

Dominant land uses: Recreation and forestry.

Gibraltar Creek is a small stream running from near Corin Dam and flowing east to Paddy's River. The upper sections have stretches of upland bog habitat. Most of the surrounding land was used for softwood plantations up until the 2003 bush fires.

CHIP SUMMARY

Two monitoring sites with 16 water quality surveys were used to produce this CHIP score.

Generally the water quality is excellent, with low nutrient levels and low Turbidity. However, low flows in warm months can drive down the Dissolved Oxygen levels to fair (67–87%).

The water quality in this reach rarely shows readings outside pristine levels and this reach is considered to be a reference in the southern ACT. The water levels are generally deeper and the flow rates faster than its sister Tidbinbilla River. This is reflected in the CHIP comparison.

OTHER NOTABLE OBSERVATIONS

Features a popular waterfall and has overnight camping facilities as well as a major private recreational centre, Corin Park, that hosts an annual music festival.

Cotter River (MCC1)

Cotter Dam to Murrumbidgee River

2013/14 CHIP RESULT B+

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 Blundell's Flat and*** terminates at the confluence with the Murrumbidgee River. Water flowing through this reach is heavily influenced by water from the Murrumbidgee River that is regularly pumped from the Cotter Pumphouse to the base of the dam wall.

CHIP SUMMARY

Two monitoring sites with 12 water quality surveys were used to produce this CHIP score, as well as a waterbug survey conducted at the Cotter campground site in autumn 2014.

Water quality fluctuates widely in the ***reach due to the influences of the Paddy's*** River, the new dam and the Murrumbidgee River recirculation.

Turbidity and Nitrate levels were excellent in this reach. A marked difference in waterbugs is found in the river above and below the dam. Consistent monitoring has only occurred at the most downstream site.

OTHER NOTABLE OBSERVATIONS

This is the major recreational waterway stretch in the ACT with several picnic spots and a well used campground along its banks. It is heavily subscribed in the warmer seasons.

Point Hut Ponds (MPG1)

2013/14 CHIP RESULT C+

REACH FACTS

Reach network length: approx. 2.5Km

Dominant land uses: Urban

Point Hut Pond sediment control pond in the suburb of Gordon is at the bottom of Conder Creek stormwater system and has been engineered with flow reduction and verge vegetation to reduce negative impacts from suburban runoff. Conder Creek arises in the Rob Roy Nature reserve and flows into the Murrumbidgee River just downstream of Point Hut Crossing.

CHIP SUMMARY

Four monitoring sites generated 24 water quality surveys that were used to produce this CHIP score.

Key concerns for this reach ***were 'degraded' levels for*** Total Phosphorus (.01-0.3mg/L) and Turbidity (10–50 NTU). Low Dissolved Oxygen (less than 65%) readings were also common.

The Pond's water level receded dramatically during summer. Extreme dry periods have a denuding effect on ground cover. High flows scour out soil from around this reach, leading to high sediment deposition and nutrient levels in the ponds.

OTHER NOTABLE OBSERVATIONS

One monitoring site is in a gross pollution trap on Conder Creek under Box Hill Ave, Conder. Another is in the suburban wetlands established at the top of Conder Creek near Tuggeranong Hill. Recent range expansion of carp upstream is a concern.

Naas River (NNN1)

2013/14 CHIP RESULT Data Deficient

REACH FACTS

Reach network length: 40Km

Dominant land uses: Rural residential, grazing, conservation

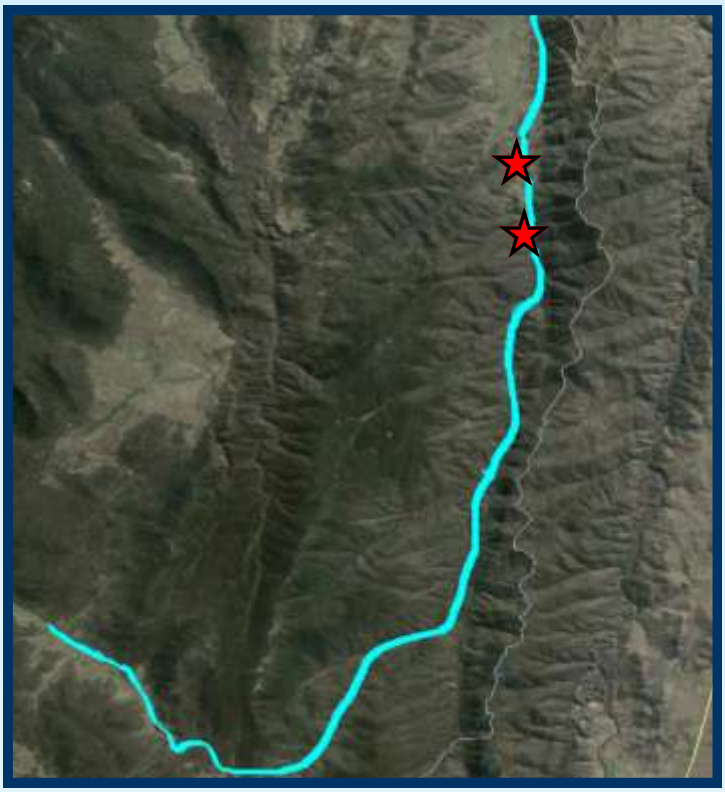
The Naas River runs south then hooks east then flows north running through the southern tip of the ACT in Namadji National Park. The lower part of the river runs past grazing properties before joining the Gudgenby River 10 Km south of Tharwa.

CHIP SUMMARY

During this census period insufficient data was entered on time for the monitoring sites on this reach.

The smaller creeks in this region such as Gudgenby Creek, suffer high Electrical Conductivity and Total Phosphorous and low Dissolved Oxygen in warm weather as they begin to dry out.

The Naas River region was identified as a *'very high' sediment risk as part of the* Actions for Clean Water (ACWA) Plan in 2012. This Plan, produced by a range of catchment stakeholders including Waterwatch, identified priority areas for remediation to help reduce Turbidity in the upper Murrumbidgee catchment.



OTHER NOTABLE OBSERVATIONS

'The Naas river in particular is a significant source of fine sand and silt/clay sediments. These fine sediments are being eroded directly from the bed and banks of the channel. The connecting tributaries are also delivering significant volumes of sediment to the Naas *river.' ACWA Plan 2012.*

Cooleman Ridge (RAN1)

2013/14 CHIP RESULT C+

REACH FACTS

Reach network area: Kathner Dam 0.05Ha, Old Dam 0.15Ha

Dominant land uses: Suburban reserve

Kathner St Dam is a small dam on Cooleman Ridge Nature Park. It was built to provide water for horses as part of the bicentennial horse trail. The 'Old Dam' is on the eastern slopes of Cooleman Ridge.

CHIP SUMMARY

Two monitoring sites generated 22 water quality surveys that were used to produce this CHIP score.

Chronically high Total Phosphorus levels exist at these sites (0.15–0.3 mg/L). This may be a result of the land use history when super phosphate was used for pasture improvement.

The 'Old Dam' is occasionally accessed by cattle when they are put in the reserve for fire management practices. When this happens the Turbidity of the dam increases dramatically (20–90 NTU).

A variety of frogs can be heard calling at these dams. Likewise, a diversity of birds, reptiles and waterbugs are regularly observed.

OTHER NOTABLE OBSERVATIONS

Originally part of the grazing estate, the 'Old Dam' is now mostly used by recreational horse riders and dog walkers.

Isabella Pond (TIP1)

2013/14 CHIP RESULT C+

REACH FACTS

Reach network area: 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 pours over a high weir at its western end into Lake Tuggeranong (TLT2).

CHIP SUMMARY

Two monitoring sites with 14 data water quality surveys were used to produce this CHIP score.

The Electrical Conductivity (EC 220–920µS) and Dissolved Oxygen levels (DO 10–97%) are ***often at 'degraded' levels. The northern site*** which is situated at a gross pollution trap was often reported to the ACT Government as having readings of concern (DO < 4mg/L, EC > 1000 µS). Turbidity and Total Phosphorus ***levels were also 'fair'.***

This CHIP score highlights the significant pollutant loads coming into this reach from the highly urbanised catchment. The need for remediation works such as wetlands has been raised by the community.

OTHER NOTABLE OBSERVATIONS

This is one of the worst CHIP scores for the Southern ACT region. While the monitoring is focussed at the gross pollution traps, which may bias the water quality scores, it does not lessen the significance of the pollution problem that exists in this pond.

Lake Tuggeranong (TLT1)

2013/14 CHIP RESULT B+

REACH FACTS

Reach network area: 56Ha

Dominant land uses: Urban and recreation

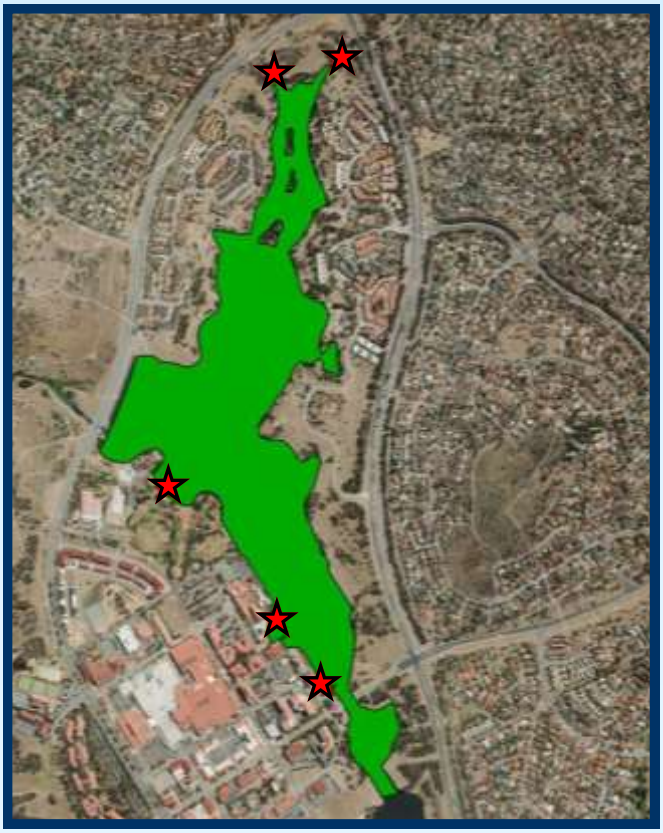
This is the main body of Lake Tuggeranong, which is fed by the stormwater systems of 13 southern suburbs. Two major Gross Pollutant Traps are at the northern end of this reach. Lake Tuggeranong wetlands (TLT2) are immediately upstream of this reach.

CHIP SUMMARY

Five monitoring sites with 35 water quality surveys were used to produce this CHIP score.

Fair Turbidity (9–400 NTU) and poor Dissolved Oxygen levels (61–127%) are common in the Lake. This reach has also suffered prolonged blue green algae blooms in the last few years.

The B+ CHIP score shows that the lake acts as a very effective settling pond. However the severe algal blooms highlight a significant nutrient load that is not necessarily picked up by our tests for Total Phosphorus. See also the CHIP reports for TUG1 and TIP1.



OTHER NOTABLE OBSERVATIONS

The lake is home to various boating clubs and is proximal to Tuggeranong's main business centre, a secondary college and many other clubs and facilities.

Lake Tuggeranong 'Wetlands' (TLT2)

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: 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 new South Quay development. It forms a narrow neck at the southern end which is fed by a large zigzag dam wall which overflows from Isabella ponds.

CHIP SUMMARY

Four monitoring sites generating 38 water quality surveys were used to produce this CHIP score.

This section of the Lake has elevated levels of Total Phosphorus (0.01–0.7 mg/L), suggesting poor water quality. Additionally, the pH of this reach is substantially lower (5.8–8.1) than the downstream reach, TLT1. This reach (TLT2) often suffers from blue green algal blooms but only in the down stream wide section. Sediment build up is also occurring in this reach.

A tall stand of mature Casuarinas at the south eastern end provide a cooling feature unique in the Lake Tuggeranong system.

OTHER NOTABLE OBSERVATIONS

This reach is the shallowest part of the lake with a sandy sediment substrate. It has little in-stream habitat although there are substantial stands of mature Casuarina along both shorelines. A large carp population makes this reach popular with fisher folk.

McQuoid's Creek (TMM1)

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: approx. 2.5Km

Dominant land uses: Rural grazing and recreation

This reach covers McQuoid's Creek and the associated dam on Westwood Farm, Kambah. A tributary of the Creek runs past the Murrumbidgee Golf club. McQuoid's creek flows into the Murrumbidgee River near Kambah Pool. The upstream sections are predominantly cleared land, while the downstream section is still well vegetated.

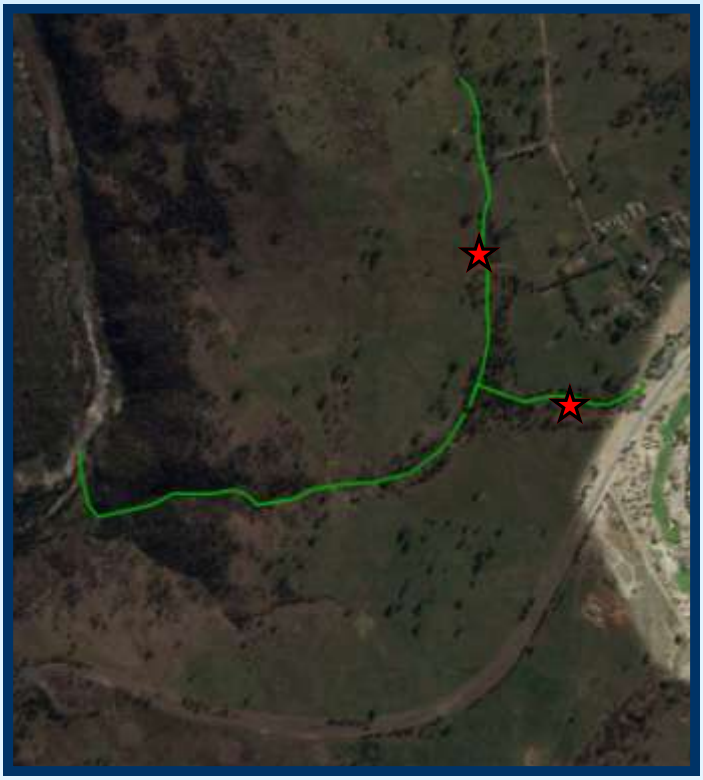
CHIP SUMMARY

Two monitoring sites with 12 water quality surveys were used to produce this CHIP score.

High pH (6.5–8.9) and high Turbidity (9–50 NTU) are common in this reach, part of which flows past the local golf club. Cattle have regular access to the dam site and this has a direct effect on the water quality readings.

Good rainfall over the last few years has had a diluting affect on the negative impacts that usually plague this Creek.

Monitoring at both sites ceased at the beginning of 2014 and has yet to be resumed.



OTHER NOTABLE OBSERVATIONS

Westwood Farm is used predominantly for horse agistment and cattle in addition to hosting social services such as Lions Youth Haven.

Tuggeranong Creek (TUG1)

Lake Tuggeranong to Murrumbidgee River

2013/14 CHIP RESULT B-

REACH FACTS

Reach network length: 1.8Km

Dominant land uses: Suburban reserve

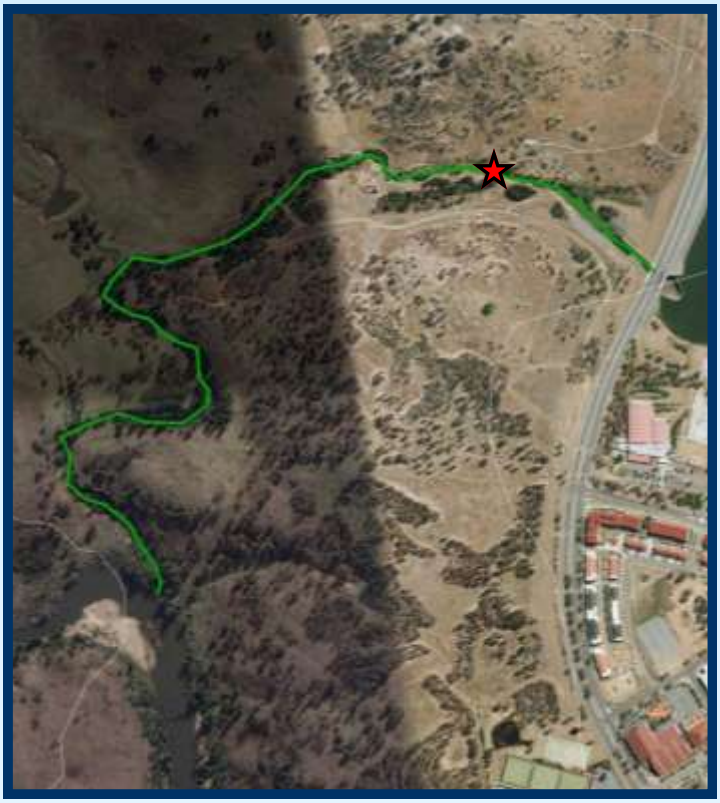
This reach includes the stretch of natural creek line fed by the overflow from Lake Tuggeranong. Although well lined with Casuarinas, most of the understory vegetation consists of weeds. The creek is also heavily overgrown with algae for most of the year.

CHIP SUMMARY

One monitoring site with 12 water quality surveys was used to produce this CHIP score, in addition to 1 waterbug survey conducted in autumn 2014.

Dissolved Oxygen levels are often 'fair'. Other water quality parameters are 'good', however the extensive algae growth in the creek suggests excessive nutrients levels which are possibly being removed by these fast growing plants. High Turbidity (300 NTU) was recorded following heavy rainfall.

The CHIP score of this creek is also testament to the water settling function of Lake Tuggeranong.



OTHER NOTABLE OBSERVATIONS

Frogwatch census surveys over the past few years have revealed disturbingly low populations in this creek. One year no frogs at all were heard even though populations had been abundant elsewhere in the southern ACT catchment.

Upper Tuggeranong Creek (TUG2)

2013/14 CHIP RESULT B+

REACH FACTS

Reach network length: Monks Creek (upper arm of reach 3.2Km), Tuggeranong Creek (lower arm of reach) 4.0Km

Dominant land uses: Rural grazing

The monitoring site is near the Monaro Hwy at the eastern border with NSW and is fed from Monks Creek to the east and Tuggeranong Creek to the south. The Tuggeranong Creek arm runs adjacent to the Monaro Hwy in NSW.

CHIP SUMMARY

One monitoring site with 2 water quality data surveys was used to produce this CHIP score.

Electrical Conductivity is often at 'poor' to 'degraded' levels. Dissolved Oxygen and pH are also often at 'fair' levels.

The low level of records making it into this census have skewed the CHIP synthesis.

Heavy algal growth suggest high nutrient levels are coming in from NSW. The Electrical Conductivity readings (350–380µS) are consistently higher than similar sized creeks to the south west in the ACT.

A consistent monitoring regime is being established with the local high school in nearby Calwell.

OTHER NOTABLE OBSERVATIONS

The Waterwatch site is at the lowest stretch of Tuggeranong creek not lined with concrete. This location often has good numbers of yabbies.

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

Electrical Conductivity: a measurement of the total combined salts/minerals within 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 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

Gambusia: A small invasive pest fish introduced from central America

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

Metamorphic: A type of rock, related to its process of formation

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

Reach: A length of waterway defined by hydrological, environmental, landuse 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: same as runoff

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

ACTEW: ACTEW Corporation

ACWA: Actions for Clean Water Plan (an initiative to reduce turbidity in the upper Murrumbidgee)

DO: Dissolved Oxygen

EC: Electrical Conductivity

Mg/L: Milligrams per Litre

µS: MicroSiemens

NTU: Nephelometric Turbidity Units

N: Nitrogen

TP: Total Phosphorus

RARC: Rapid Appraisal of Riparian Condition

TSR: Travelling Stock Reserve

Appendix I. CHIP Scores by parameter

Cooma Region CHIP Scores by Parameter

Reach	pH	EC	Turbidity	Total Phosphorus	DO	Nitrate	Aggregate WQ score	Waterbug Score	Aggregate WQ+WB score	
BAD1	2	2	1	2	3	1	1.83	2.5	2.06	B+
BAD2	2	1	1	2	3	1	1.67	2	1.78	A-
BRD1	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	1	1.00	A+
BRD2	2	2	1	3	3	1	2	3	2.33	B+
CMM1	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	
CMM2	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	
CMM3	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	1.5	1.50	A
CMM4	2	2	1	2.5	2	1	1.75	3	2.17	B+
CMM5	3	2	3	1	3	1	2.17	2	2.11	B+
COO1	2	5	1	5	5	1	3.17	2	2.78	B-
GUD1	3	5	1	2	3	1	2.5	2	2.33	B+
NUM1	2	2	1	3	2	1	1.83	3	2.22	B+
NUM2	2	2	5	2	5	1	2.83	3	2.89	B-
NUM3	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	3	3.00	C+
NUM4	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	3	3.00	C+
ROC1	4	5	1	3	5	1	3.17	2	2.78	B-
STR1	3	2	1	3	5	1	2.5	3.5	2.83	B-

EC = Electrical Conductivity, DO = dissolved Oxygen, WQ = Water Quality, WB = Waterbug

Ginninderra CHIP Scores by Parameter

Reach	pH	EC	Turbidity	Total Phosphorus	DO	Nitrate	Aggregate WQ Score	Waterbug Score	Aggregate WQ+WB Score	
BEL1	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	
GDC1	2	3	5	2	2	Data Deficient	2.8	Data Deficient	2.80	B-
GIN1	2	3	5	2	3	Data Deficient	3	4	3.33	C+
GIN2	2	3	1	2	4	1	2.17	2	2.11	B+
GIN3	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	4	4.00	D+
GIN4	2	3	1	3	2	2	2.17	3	2.44	B
GIN5	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	
GOO1	2	5	1	3	5		3.2	Data Deficient	3.20	C+
GUN1	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	
GUN2	2	5	5	2	5	1	3.33	4	3.56	C
YER1	4	3	1	2	2	2	2.33	2	2.22	B+
CMM10	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	

EC = Electrical Conductivity, DO = dissolved Oxygen, WQ = Water Quality, WB = Waterbug

Molonglo CHIP Scores by Parameter

Reach	pH	EC	Turbidity	Total Phosphorus	DO	Nitrate	Aggregate WQ Score	Waterbug Score	Aggregate WQ+WB score	
BAL1	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	
BTT1	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	
BUR1	4	5	5	1	3	1	3.17	2	2.78	B-
DIC1	3	2	1	2	5	1	2.33	Data Deficient	2.33	B+
GGG1	2	5	1	1	2	3	2.33	Data Deficient	2.33	B+
JER1	2	3	1	1	Data Deficient	1	1.6	Data Deficient	1.60	A
JER2	3	5	1	2	Data Deficient	1	2.4	Data Deficient	2.40	B
JER3	2	5	5	Data Deficient	5	1	3.6	4	3.73	C-
LBG1	2	5	5	1	5	2	3.33	Data Deficient	3.33	C+
LBG2	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	
MOL1	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	
MOL2	2	3	1	3	3	1	2.17	4	2.78	B-
MOL3	2	5	1	1	5	1	2.5	3	2.67	B
MOL4	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	
MOL5	2	3	5	3	3	2	3	Data Deficient	3.00	C+
MOL6	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	4	4.00	D+
PRI1	2	5	1	1	3	1	2.17	Data Deficient	2.17	B+
QUE1	2	2	1	2	3	1	1.83	2	1.89	A-
QUE2	3	2	1	1	2	1	1.67	2	1.78	A-
QUE3	4	2	1	2	2	2	2.17	2	2.11	B+
SCA1	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	
SUL1	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	
SUL2	Data Deficient	2	1	Data Deficient	Data Deficient	Data Deficient	1.5	4	2.33	B+
SUL3	2	3	1	5	5	Data Deficient	3.2	4	3.47	C
SUW1	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	
WAT1	2	2	5	1	5	1	2.67	Data Deficient	2.67	B+
WES1	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	
WOO1	2	5	1	1	5	2	2.67	2	2.44	B
YAN1	1	1	1	4	3	1	1.83	Data Deficient	1.83	A-
YAR1	2	5	5	3	5	1	3.5	4	3.666666667	C

EC = Electrical Conductivity, DO = dissolved Oxygen, WQ = Water Quality, WB = Waterbug

Southern ACT CHIP Scores by Parameter

Reach	pH	EC	Turbidity	Total Phosphorus	DO	Nitrate	Aggregate WQ Score	Waterbug Score	Aggregate WQ+WB score	
CGB1	2	2	1	3	5	2	2.5	3	2.67	B
CGG1	2	2	1	3	2	Data Deficient	2	Data Deficient	2.00	B+
CGH1	2	2	1	2	3	2	2	3	2.33	B+
CMM6	2	2	1	3	2	Data Deficient	2	Data Deficient	2.00	B+
CMM7	2	2	1	5	2	Data Deficient	2.4	3	2.60	B
CMM8	3	2	1	2	2	Data Deficient	2	4	2.67	B
CMM9	2	2	1	2	2	1	1.67	4	2.44	B
CTP1	2	2	1	1	2	1	1.5	2	1.67	A-
CTT1	2	2	1	2	2	1	1.67	3	2.11	B+
GIB1	2	1	1	1	3	1	1.5	Data Deficient	1.50	A
MCC1	2	2	1	2	2	1	1.67	3	2.11	B+
MPG1	2	2	5	5	2	2	3	Data Deficient	3.00	C+
NNN1	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	Data Deficient	
RAN1	2	2	5	5	2	Data Deficient	3.2	Data Deficient	3.20	C+
TIP1	2	5	3	3	5	2	3.33	Data Deficient	3.33	C+
TLT1	2	2	1	2	3	Data Deficient	2	Data Deficient	2.00	B+
TLT2	1	2	1	4	2	2	2	Data Deficient	2.00	B+
TMM1	2	2	5	1	2	1	2.17	Data Deficient	2.17	B+
TUG1	2	2	1	2	5	2	2.33	4	2.89	B-
TUG2	2.5	4	1	1	2.5	Data Deficient	2.2	Data Deficient	2.20	B+

EC = Electrical Conductivity, DO = dissolved Oxygen, WQ = Water Quality, WB = Waterbug

Appendix II. Reach Philosophy & Methodology

Two primary functions of the Upper Murrumbidgee Waterwatch (Waterwatch) program is to facilitate public engagement in the monitoring and care of local waterways, and provide data to support an early warning system for environmental perturbations. A key output of this program is the annual Catchment Health Indicator Program (CHIP), which provides a numerical score of catchment health. The CHIP utilises a majority of the waterwatch collected data (See Appendix III: CHIP Philosophy & Methodology).

Strengths and Limitations

Both strengths and limitations of the CHIP are in part due to the reporting of the data at meaningful spatial scales. Due to limited resources and the logistics of regular sampling (which is conducted almost entirely by volunteers), a trade-off exists between reporting at small spatial scales with limited amounts of data, and a lack of spatial resolution that can occur when attempting to maintain high data confidence by combining sites that underpin the CHIP score.

Previous CHIP

The previous approach to reporting the CHIP has been primarily at the sub-catchment scale. This is achieved by aggregating the data of multiple sampling sites within the sub-catchment boundary. The strength of this approach is that it can maximise the amount of data available to produce a CHIP score, yet is also inflexible and in catchments that are data-poor, can lead to unreasonable inferences regarding catchment health. Furthermore, 'health' can vary within catchments, and aggregating data can mask important underlying sources of variability within catchments, inhibiting appropriate inferences and management responses. This, however, can be partly negated by careful examination and comparison of sites within catchment boundaries.

UC Review

Following a review of the data integrity and CHIP methodology conducted by the Institute for Applied Ecology, University of Canberra (Harrison et al. 2013), it was proposed that Waterwatch move away from a sub-catchment based approach to presenting the CHIP, and adopt a reach-based approach. The proposed benefits of moving to a reach-based approach include providing greater spatial resolution of health where sufficient data can underpin those inferences, and remove over-extension where insufficient data exists within a sub-catchment. This approach facilitates the detailed reporting of changes in health related to specific management interventions (eg. riparian planting programs, erosion control) or conversely, reporting on specific environmental stressors (eg. point-source pollution, urban development), where sufficient data is present.

How we defined reaches

Harrison et al. (2013) outlined 4 alternate approaches to defining reaches:

1. Expert opinion: reaches are defined using local experts to delineate significant changes in hydrology and land-use practices.
2. Catchment area increases: reaches are defined based upon a set rule regarding the change in catchment area (which correlates strongly with river discharge).
3. Tributary inputs: closely aligned with the stream order concept.
4. Mapped stream characteristics: a desktop based assessment of reaches using known information on hydrology, geology and catchment use.

The approach adopted by the Waterwatch is to use expert opinion to define reaches. The expert opinion has been provided by the Waterwatch co-ordinators. Reaches are defined based on number of sampling sites, management interventions and changes in land use/hydrology including anticipated land use changes. This will be an iterative process, and will change over time as land use, management practises and sampling sites change. This enables a more adaptive approach to reporting catchment health.

In defining reaches, a key consideration is the amount of data present to compute an indicator score. Harrison et al. (2013) recommend that a minimum of 3 sampling sites exist within a defined reach (Figure A1). This data is then aggregated to produce an indicator score for that reach. This is ideal, yet practical limitations mean that 3 sites per may be unachievable in some instances. As such, a majority reaches have been defined based on a minimum of 2 sites, with a small number defined based on a single site. These reaches with single sites are now high priorities for establishing additional sampling sites. A long-term objective will be to have a minimum of 2 sampling sites in every reach. Some reaches have several sampling sites (eg. Lower Queanbeyan River) due to a large number of sites situated in close proximity.

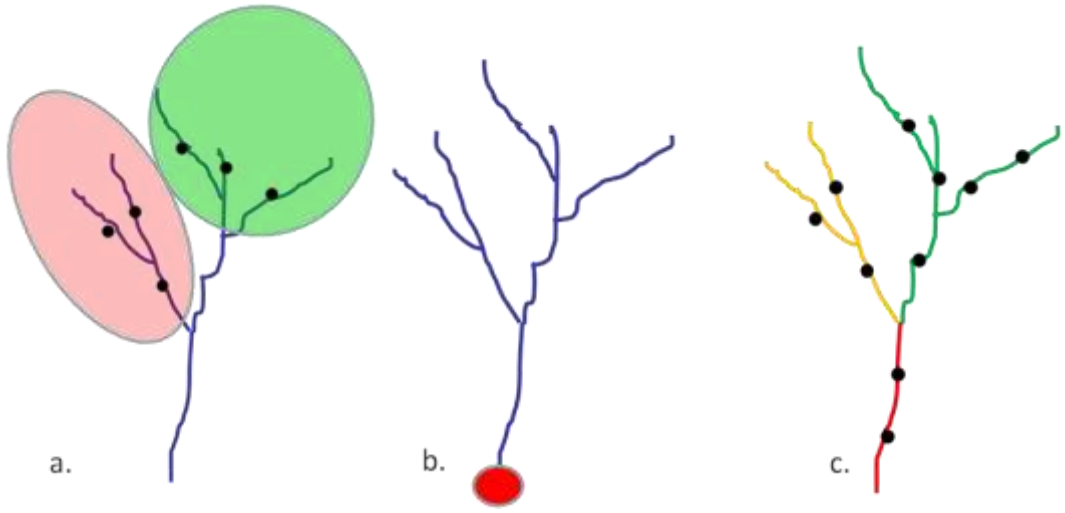


Figure A1. Popular ways of measuring catchment/river health (a) sub-catchment; (b) end of catchment (c) reach based with different ratings for each reach shown by colours. Dots represent sample sites. From Harrison et al. (2013).

The second major factor contributing to the definition of reaches was significant changes in hydrology, land use, and targeted management works. Ideally, reaches should comprise of sections of catchments in which there are no significant changes in any of these parameters. However, this isn't always achievable, or known. Using the expert opinion available, and constrained by the number of sampling sites currently established (which vary greatly in density across the Upper Murrumbidgee catchment), we defined reaches where there were no major changes in land use or hydrology, and to enable reporting of changes to catchment health related to habitat remediation works, and known or potential stressors. As stated previously, the definition of reaches is more flexible than using sub-catchment boundaries, and can change through time to align with reporting on key environmental issues within our catchments. This approach will ensure that this citizen science and community engagement tool can be best applied to inform and improve the management and health of our waterways.

References

Harrison, E., Dyer, F., Gruber, B., Nichols, S., and A. Tschierschke (2013) Waterwatch data and catchment health indicator review. Report to ACT Government. Institute for Applied Ecology, University of Canberra.

Appendix III. CHIP Philosophy & 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 an awareness and communication tool, in addition to providing information to inform management and policy regarding water resource use and protection. However, multiple complex calculations are involved in producing the CHIP, and numerous catchment groups around Australia produce similar (albeit slightly different) CHIPs. Conversely, specific details regarding these CHIPs are not generally forthcoming. This document aims to clearly outline the underlying philosophy and methodology regarding the Waterwatch 2013–2014 CHIP.

The CHIP Philosophy

The CHIP is a tool for reporting an annual update on the health of our waterways. This is primarily a communication tool, with the overarching objective being to inform the public and stakeholders of the current condition of our waterways, and highlight changes due to environmental degradation, and improvements due to management and rehabilitation works. In order to achieve this, numerous sources of data are combined to produce a single composite value of catchment health (the indicator). A key issue here is the spatial scale at which differences in catchment health are reported. This is a complex problem, and is dependent on the underlying nature of the catchment, land use practices and current management objectives. These are also coupled with the amount of data present with which to calculate a CHIP score. This is discussed further in Appendix II.

Multiple Types of Data

Waterwatch volunteers and co-ordinators collect data relating to water quality, macro-invertebrate 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 co-ordinators also collect aquatic macro-invertebrate 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) assessments are conducted by volunteers and co-ordinators 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 data are combined into the CHIP. Finally, additional data regarding algae abundance and diversity, frog abundance and diversity, and platypus abundance are used to provide context regarding catchment health, but are not formally included in the CHIP calculations (Table A1).

Table A1. Summary of waterway health parameters collected by volunteers and co-ordinators, that are included in the CHIP. These values here reflect current goals, but are not always achieved in all instances.

Water Quality	Parameter	Frequency	Number of sites
	pH	Monthly	All sites
	Electrical Conductivity	Monthly	All sites
	Turbidity	Monthly	All sites
	Total Phosphorus	Monthly	All sites
	Nitrate	Monthly	All sites
	Dissolved oxygen Temperature	Monthly	All sites
Macro-invertebrates			
	SIGNAL 2.0	Biannual (spring & autumn)	Key sites (min 1/reach)
Riparian Condition			
	RARC	Biennial	All sites

Water Quality Parameters

Currently, volunteers strive to collect water quality data for multiple parameters every month (Table A1). 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 previously (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.

Based upon previously published values (Walker and Reuter 1996; ANZECC 2000; ACT Government 2005), a set of values are calculated to indicate condition (Table A2). For each of the water quality parameters assessed each year, the modal values are used preferentially, as average (mean) values are prone to being skewed by outlier values. For the majority of water quality parameters, the data is not normally distributed. If a modal value does not exist, the median value is used instead. For some of these parameters, expert opinion has informed the cut-offs between categories, where insufficient scientific data exists to inform these cut-offs. Numerous approaches exist for calculating these cut-offs, and current definitions of cut -offs may change in the future as new data and scientific knowledge becomes available.

Table A2. Summary of Water Quality parameters, and the cut-offs between the CHIP score categories. These values are based on published values (Walker and Reuter 1996; ANZECC 2000; ACT Government 2005), and informed estimates. Dissolved oxygen (mg/L) is not included, as it is highly correlated with dissolved oxygen saturation, and is influenced by water temperature.

Indicator Rating	Excellent 1	Good 2	Fair 3	Poor 4	Degraded 5	Comment
pH	6 – 7	5.5 – 6 or 7 – 8	8 – 8.5	5 - 5.5 or 8.5 - 9	<5 or >9	
EC (µS)	<=65	<=200	<=350	<=400	>400	
Turbidity (NTU)	<=10	<=12.5	<=15	<=20	>20	
Dissolved oxygen (mg/L)						Not included in CHIP
DO saturation (%)	95 – 105	85 – 95 or 105 – 110	75 – 85	65 – 75 or 115 – 120	<65 or >120	
Total 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	

Macro-invertebrates

Aquatic fauna (and flora) are ideal indicators of catchment health, as they are entirely dependent on the waterway for their existence. Aquatic macro-invertebrates 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 macro-invertebrate assemblages (eg. AUSRIVAS, SIGNAL, ALT) and are similar in many respects. Waterwatch use SIGNAL 2.0, with macro-invertebrate 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, 2003).

The SIGNAL 2.0 score obtained at each site receives an additional calculation to produce a modified stream pollution index. This helps to control for the diversity of macro-invertebrates found at a site. This number is transformed (similar to the water quality parameters, above), and the two sampling periods (spring and autumn) averaged, before being included in the CHIP (Table A3).

Table A3. Summary of SIGNAL 2.0 scores, and cut-offs between the CHI score categories.

		# of macro-invertebrate orders	
		0 - 7	> 7
SIGNAL score	> 5.5	Fair 3	Excellent 1
	<= 5.5	Poor 4	Good 2

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. Due to reduced capacity, RARC assessments were not conducted for the two years prior to 2014. This data will be incorporated into the CHIP in 2014–2015.

Combining Water Quality, Macro-invertebrate and RARC Data

To produce a composite water quality score, the scores for each water quality parameter at a site are averaged. To produce the CHIP score, the composite water quality, macro-invertebrate and RARC scores are averaged. This current approach means that water quality, macro-invertebrates and RARCs are equally weighted in the CHIP. However, in the event that one of these is missing, a CHIP score is still produced, but the weighting of the missing category is assigned to the water quality data. In the event that water quality data is missing, the weighting is split equally between macro-invertebrates and RARC.

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 15% of total potential 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 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 <15% of data was collected, the water quality data is not included in the computation of a CHIP score. 15% was chosen due to reduced capacity over the 2013–2014 sampling period, and is likely to be raised in following years (2014–2015).

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, landuse and history of the catchments. Their expert knowledge is critical to ensuring valid interpretations of the CHIP scores.

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