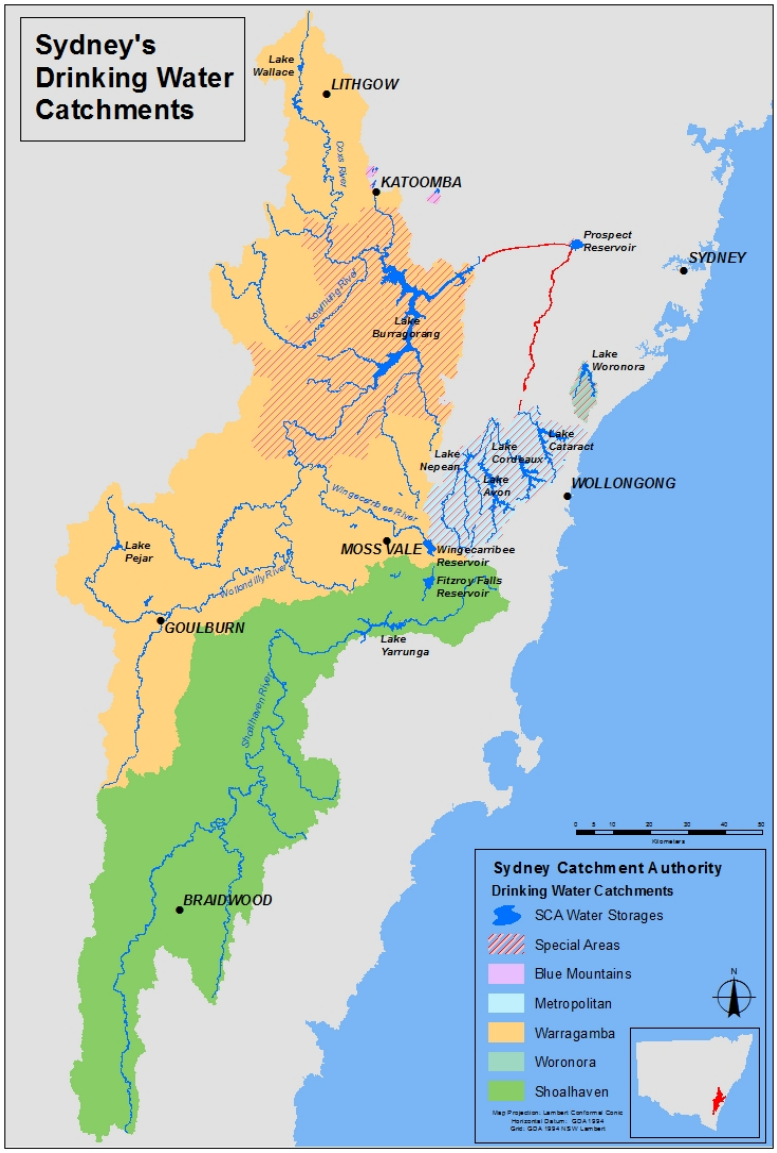

2013 Audit of the Sydney Drinking Water Catchment

Volume 3 - Appendix I

November 2013

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1. Appendix I: Sub-catchment summaries

This Section provides summaries of the 28 sub-catchments, which comprise the Sydney Drinking Water Catchment. The summaries provide a useful snapshot of the pressures and state (conditions) of each sub-catchment; and responses by the SCA and other major stakeholders (i.e. environmental monitoring and management actions).

1.1 Interpretation of Sub-catchment Summaries

The key information on the sub-catchment conditions, summarised are:

- Land use (ALUM 7 Classes and selected Tertiary Classes);
- NSW AUSRIVAS indicators of river health;
- Water availability; and
- Water quality of catchment streams and storages (SCA water quality monitoring sites)

1.1.1 Land Use

The key ALUM 7 land use classes, and the selected tertiary classes, and ALUM 7 codes for each land use category, considered in this audit period are as follows;

- 1.0.0 - Conservation and Natural Environments
- 2.0.0 - Production from Relatively Natural Environments
  - 2.2.0 - Production forestry
- 3.0.0 - Production from Dryland Agriculture and Plantations
  - 3.1.0 - Plantation forestry
  - 3.2.0 - Grazing modified pastures
  - 3.3.0 - Cropping
  - 3.6.0 - Land in transition
- 4.0.0 - Production from Irrigated Agriculture and Plantations
  - 4.2.0 - Grazing irrigated modified pastures
- 5.0.0 - Intensive Uses
  - 5.2.0 - .Intensive animal husbandry
  - 5.3.0 - Manufacturing and industrial
  - 5.4.0 - Residential and farm infrastructure
  - 5.5.0 - Services
  - 5.6.0 - Utilities + 5.7.0 - Transport and communication
  - 5.8.0 - Mining
  - 5.9.0 - Waste treatment and disposal
- 6.0.0 - Water
  - 6.5.0 - Marsh/wetland

1.1.2 Macroinvertebrate Communities: NSW AUSRIVAS Model

The appropriate NSW AUSRIVAS (Australian River Assessment System) model and accompanying scores and bandings have been utilised to detect any changes in observed and expected macroinvertebrate communities within the studied catchments.

AUSRIVAS generates site-specific predictions of the macroinvertebrate fauna expected to be present in the absence of environmental stress. The expected fauna from sites with a similar set of physical and chemical characteristics are then compared to the observed fauna, and the ratio derived is used to indicate the extent of the impact.

This ratio can range from zero (0), when none of the expected taxa are found at a site, to approximately one (1), when all of the expected taxa are present. The value can also be greater than one (1) when more families are found at the site than were predicted by the model. The ratio scores are then placed in bands that provide an indication of the assessed condition displaying the site as more biologically diverse than reference (band X), reference condition quality (band A), below reference quality (band B), well below reference quality (band C) or impoverished (band D).

Some site samples may also fall outside the experience of the AUSRIVAS model (OEM) which often suggests that the environmental variables measured at the site do not fit into any of the band categories of the reference sites. This is not an indication that the site is highly degraded; rather, it indicates that further sampling and analysis may be required to determine an assessment of river health for the site.

A description of the AUSRIVAS Bands and a colour code system is provided (Table I 1-1) which is intended to facilitate visual representation of the AUSRIVAS Bands. The colour code system is common among tables and figures where AUSRIVAS results are presented.

Table I 1-1 Explanation of AUSRIVAS Observed/Expected bands

Band Label	O/E Bandwidth	Band Name	Comments
Band X	1.17 - infinity	More biologically diverse than reference sites	More taxa found than expected. Potential biodiversity hot-spot. Possible mild organic enrichment.
Band A	0.84 - 1.16	Reference condition	Most/all of the expected families found. Water quality and/or habitat condition roughly equivalent to reference sites. Impacts on water quality and habitat condition have not resulted in a loss of macroinvertebrate diversity.
Band B	0.52 - 0.83	Significantly impaired	Fewer families than expected. Potential impact either on water quality or habitat quality or both, resulting in loss of taxa.
Band C	0.2 - 0.51	Severely impaired	Many fewer families than expected. Loss of macroinvertebrate biodiversity due to substantial impacts on water and/or habitat quality.
Band D	0 - 0.19	Extremely impaired	Few of the expected families remain. Extremely poor water and/or habitat quality. Highly degraded.
OEM	N/A	Outside Experience of the Model	This site is outside the experience of the model (Chi^2< 0.001)

Summary of AUSRIVAS Results

The results of AUSRIVAS analysis of macroinvertebrate sample data presented in the following sub-catchment summaries are a comparison of AUSRIVAS data for the current 2010 to 2012 audit period to findings of the previous audit (DECCW 2010), as presented in the sub-catchment summary tables of Volume 2.

A summary of most recent AUSRIVAS results for each of the macroinvertebrate monitoring sites for which data was provided for the current audit period is presented in Figure I 1-1. The most recent result for each site is presented following the precautionary principle where by the lowest rated sample (where two habitat samples have been collected) is used to provide an indication of the most severely impacted habitat at the site, as a general assessment of site condition. Where AUSRIVAS results are presented in figures and tables of the sub-catchment summaries all historic data, including results from 2001 to 2009, are taken from the summary tables of Volume 2 of the previous Audit (DECCW 2010). All AUSRIVAS results presented for the current audit period were provided by SCA and OEH.

SCA Macroinvertebrate Data Summary

AUSRIVAS data for the 2010 to 2012 Audit period provided by SCA represent results of the SCA Macroinvertebrate Monitoring Program (MMP), which is conducted annually in spring. SCA has provided results for 69 sites which were sampled from 2010 to 2012 and a total of 296 macroinvertebrate samples were collected, 205 of which were from edge habitats and 91 from riffle habitats. A total of 44 sites had no riffle habitat present and duplicate edge samples were collected. Analysis of O/E 50 results showed that the SCA MMP samples were predominantly rated as significantly impaired (band B), and this was evident for both edge and riffle habitats.

OEH Macroinvertebrate Data Summary

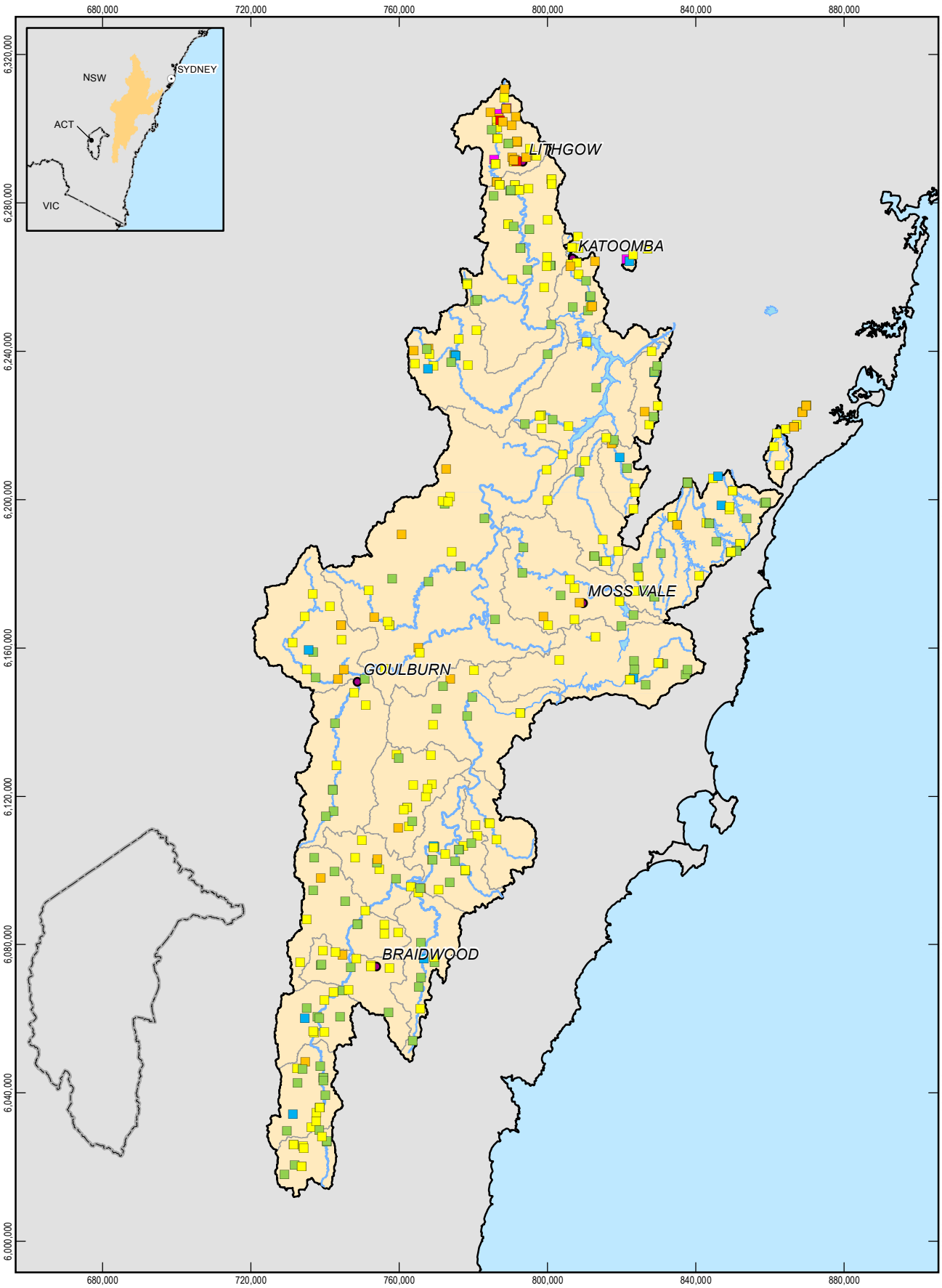
Results of AUSRIVAS analysis of OEH data was provided for monitoring in the Hawkesbury-Nepean catchment and all samples were collected in autumn 2011. A total of 66 sites were sampled only six of which had riffle habitat present. The OEH sampling program differs from the SCA MMP as no duplicate samples are collected where only one habitat is present, so in total 72 macroinvertebrates samples were collected by OEH within the Catchment from 2010 to 2012. Similar to the SCA data, analysis of O/E 50 results showed that the OEH samples were predominantly rated as significantly impaired (band B), and this was also evident for both edge and riffle habitats.

1.1.3 Water availability

A summary of water availability considering surface water flows, environmental flows and bulk water transfers for each sub-catchment is provided. Flow data from SCA gauges within each sub-catchment is considered for this current audit period and this assessment is consistent with previous audits. Summary tables are presented for each of the sub-catchments which identify the gauges assessed and provide a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

1.1.4 Water quality of catchment streams and storages

Where available, a summary of results of water quality monitoring undertaken in each sub-catchment, and water storage, is provided. Data is evaluated against the relevant ANZECC (2000) guideline values. The key water quality variables considedered include; total nitrogen mg/L (TN); total phosphorus mg/L (TP); electrical conductivity mS/cm (EC); chlorophyll à µg/L (Chl-à).



LEGEND

- Town
- Drainage
- Waterbody
- SCA catchment boundary
- Sub-catchment boundary
- State boundary

Most recent AUSRIVAS band and description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model

Paper Size A4

0 10 20 30 40 50

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Sydney Catchment Authority
Catchment Audit 2013

Job Number	23-14960
Revision	0
Date	26 Nov 2013

Recent Macroinvertebrate AUSRIVAS health ratings in the Catchment

Figure I 1-1

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Level 6, 20 Smith Street Parramatta NSW 2150 Australia T 61 2 8898 8800 F 61 2 8898 8810 E ptamail@ghd.com W www.ghd.com

Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

1.2 Upper Coxs River

1.2.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Upper Coxs River sub-catchment are shown in Figure I 1-2.

The main ALUM7 tertiary land use classes are: production forestry (30.26%), grazing modified pastures (26.48%) and Conservation or Natural Environments - other minimal uses (23.46%). The prominent land uses of the Intensive Uses Class are: Residential and farm infrastructure (4.52%), Services (3.59%) and Mining (2.46%). The city of Lithgow is the largest urban residential area in the sub-catchment with a population of 20 790 (ABS, 2013).

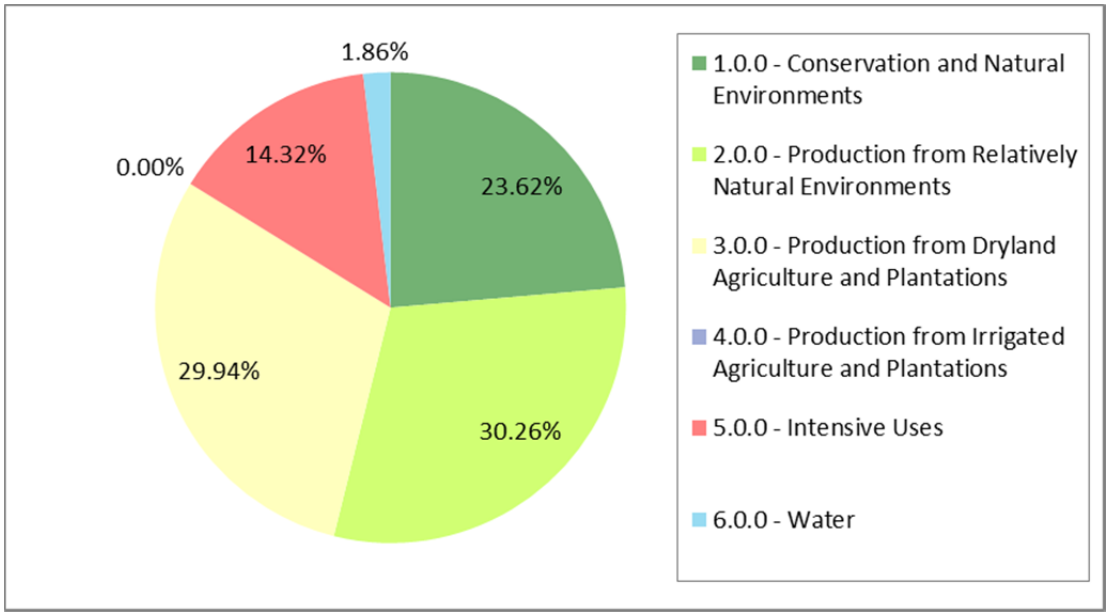


Figure I 1-2 Land use in the Upper Coxs River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Upper Coxs River sub-catchment were primarily sourced from the SCA, and OEH. Results of monitoring programs conducted by Delta Electricity have been provided during the previous audit but were not provided for inclusion of analysis for this current audit. The results are summarised in Figure I 1-3, Figure I 1-4 , Figure I 1-5, and Table I 1-2.

A total of 83 macroinvertebrate samples have been collected from the Upper Coxs River including historic samples and all sample data provided by SCA, OEH and Delta Electricity (to 2009). The majority (40.2%) of these samples were rated as significantly impaired (band B) or severely impaired (band C) by AUSRIVAS. A small number of samples were assessed to more biologically diverse than reference condition (band X) (1.2%) or extremely impaired (band D) (2.4%) with the remaining samples falling outside the experience of the AUSRIVAS model (4.9%).

A long-term SCA macroinvertebrate monitoring site (A16) has been consistently sampled since 2001 and macroinvertebrate sample data exists for an additional 41 sites which have been sampled at least once. Seven sites have been sampled during this audit period (2010-2012)

with the majority (4) of these samples assessed by AUSRIVAS as significantly impaired (band B). Results of A16 have shown this site to decline in condition from 2009 to 2012; however, a comparison of all results from 2007-2009 (presented in the previous audit) to AUSRIVAS results for the 2010 to 2012 period (Figure I 1-4) shows a general improvement across the Upper Coxs River sub-catchment. The increase of both the significantly impaired (band B) and reference condition (band A) condition sites from the previous audit period to the current audit period is the key reason for this change in condition across the catchment; however, this may be influenced by the addition of sites which have not been sampled in the past so may not actually represent a temporal change.

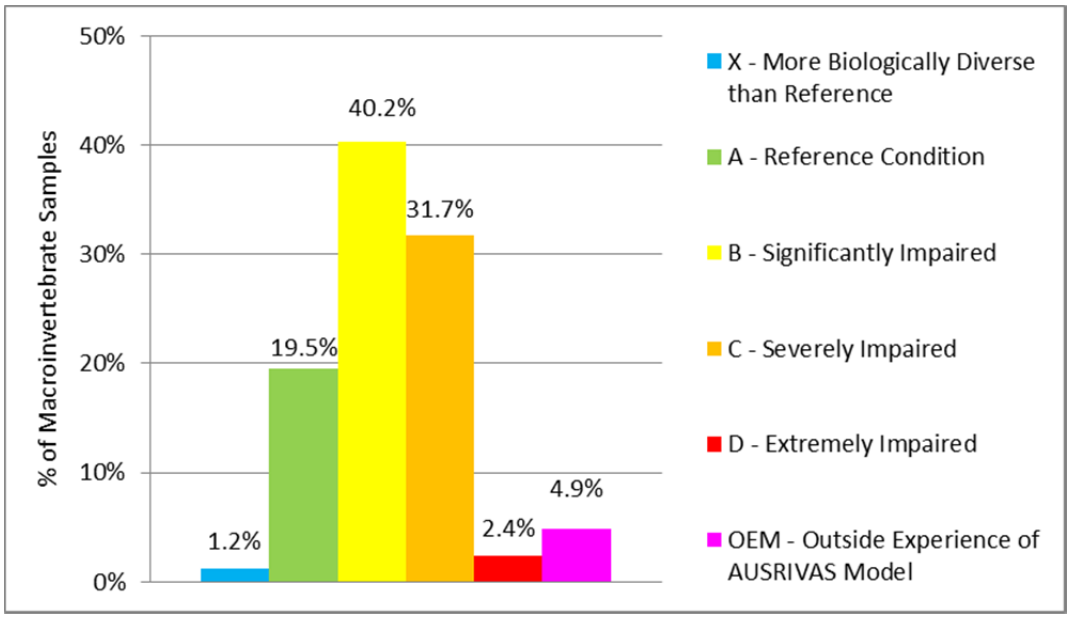


Figure I 1-3 Distribution of AUSRIVAS bands for all macroinvertebrate sample data provided for the Upper Coxs River sub-catchment

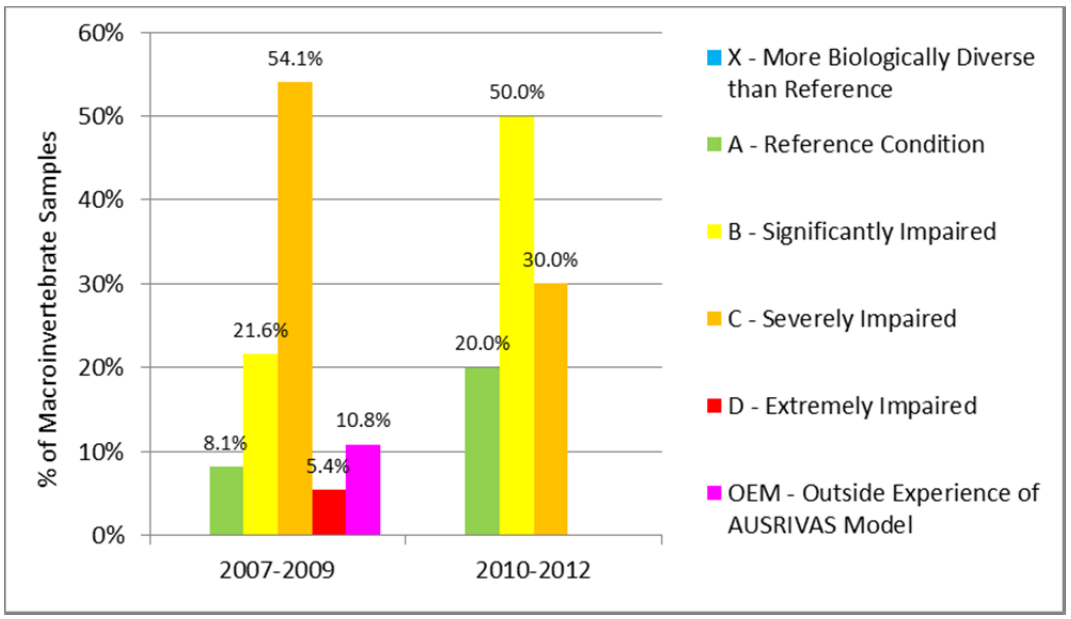
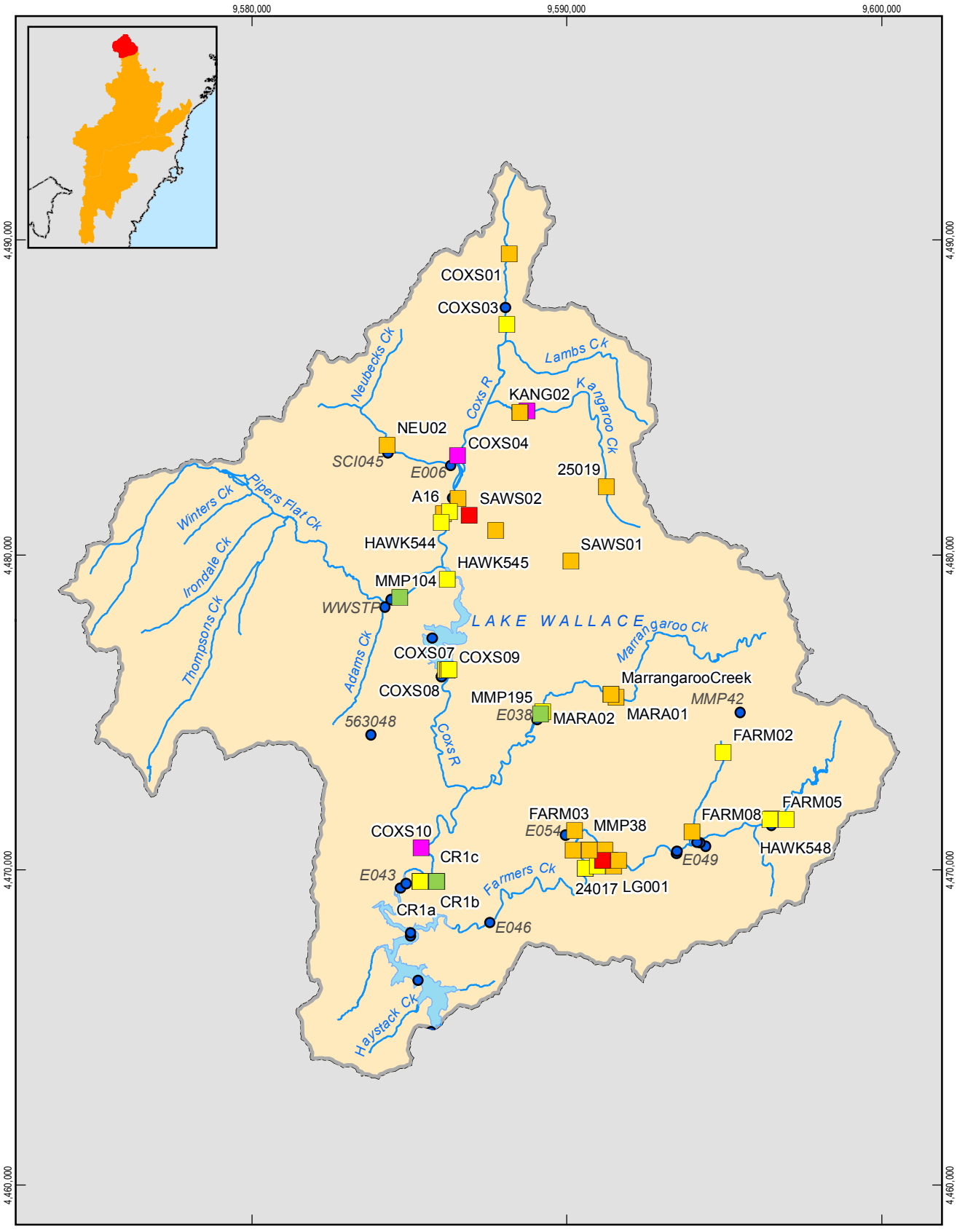


Figure I 1-4 Comparison of AUSRIVAS results from the Upper Coxs River sub-catchment: 2007-09 to 2010-12



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model

Water Quality Monitoring Site

Waterbody

Waterway

Sub-catchment Boundary

Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Sydney Catchment Authority
Catchment Audit 2013

Upper Coxs River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number 2314960
Revision 0
Date 26 Nov 2013

Figure I1-5

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Level 6, 20 Smith Street Parramatta NSW 2150 Australia T 61 2 8898 8800 F 61 2 8898 8810 E ptamail@ghd.com W www.ghd.com

Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

Table I 1-2 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Upper Coxs River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
24017	Edge	-33.48097	150.12993								A					
24017	Edge	-33.48097	150.12993								B					
25019	Edge	-33.37146	150.13316										C			
A16	Edge	-33.38059	150.07798		A	X	A	A	B	A	B	A	B	B	B	C
COXS01	Edge	-33.30573	150.09781										C		C	
COXS03	Edge	-33.32592	150.09762										B			
COXS04	Edge	-33.36392	150.08216										OEM			
COXS05	Edge	-33.3762	150.08276										C			
COXS06	Edge	-33.37999	150.07998										B			
COXS07	Edge	-33.4253	150.080126										C		B	
COXS08	Edge	-33.425431	150.080713										C			
COXS09	Edge	-33.42531	150.08135										C		B	
COXS10	Edge	-33.47656	150.07369										OEM			
CR1a	Edge	-33.486168	150.076972			B	B	B								
CR1a	Riffle	-33.486168	150.076972			B	B	B								
CR1b	Edge	-33.486168	150.076972			B	A	A								
CR1b	Riffle	-33.486168	150.076972			B	A	B								
CR1c	Edge	-33.486168	150.076972			B	A	B								
CR1c	Riffle	-33.486168	150.076972			B	B	A								
FARM02	Edge	-33.44656	150.17587										B			
FARM03	Edge	-33.47028	150.12596										C			
FARM05	Edge	-33.46527	150.19327										C			
FARM06	Edge	-33.47862	150.13836										OEM			
FARM08	Edge	-33.46959	150.16614										C			
HAWK544	Edge	-33.3832	150.0772	B												
HAWK545	Edge	-33.3995	150.0798	B												
HAWK547	Edge	-33.4802	150.1374	B												

Table I 1-2 (cont.) AUSRIVAS ranking of macroinvertebrate monitoring sites in the Upper Coxs River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
HAWK547	Riffle	-33.4807	150.138	C												
HAWK548	Edge	-33.4653	150.196	B												
HAWK548	Riffle	-33.4653	150.196	B												
HAWK556	Edge	-33.4756	150.1343	B												
HAWK556	Riffle	-33.4756	150.1343	C												
KANG02	Edge	-33.35056	150.10544										OEM			
KangarooCreek	Edge	-33.351	150.103								A					
KangarooCreek	Edge	-33.351	150.103								C					
LG001	Edge	-33.47857	150.13916									D				
LG001	Riffle	-33.47857	150.13916									C				
MARA01	Edge	-33.43174	150.1388										C			
MARA02	Edge	-33.43649	150.11387										B			
MarrangarooCreek	Edge	-33.431	150.137								B					
MarrangarooCreek	Edge	-33.431	150.137								C					
MMP104	Edge	-33.40491	150.06386					A								
MMP195	Edge	-33.43731	150.11307							A						
MMP38	Edge	-33.47594	150.12906			C					C	C				
MMP38	Riffle	-33.47594	150.12906								C	C				
NEU02	Edge	-33.36143	150.058										C			
SAWS01	Edge	-33.39308	150.12184										C			
SAWS02	Edge	-33.3809	150.086725										D			
SawyersSwampCreek	Edge	-33.385	150.096								C					
24110	Edge	-33.47197	150.08388												A	
24110	Riffle	-33.47197	150.08388												A	
KANG02_ds	Edge	-33.3506	150.10542												B	
KANG02_us	Edge	-33.3506	150.10542												C	

Water availability

Surface water flow

Flow data from five gauges within the Upper Coxs River sub-catchment was considered under this current audit. The assessment of these gauges is consistent with previous audits. Table I 1-3 identifies the gauges assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods, and also the long term trend.

Table I 1-3 Flow (ML/day) at gauging stations in the Upper Coxs River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
212008	Coxs River at Bathurst Road	09/02/1951	13.86	8.51	13.42	15.51	23.93
212058	Coxs River upstream of Lake Lyell	15/12/2000	20.56	14.23	18.93	24.13	34.62
212055	Neubecks Creek upstream of Wallerawang	07/12/1991	0.59	0.14	0.10	0.30	1.60
212042	Farmers Creek at Mt Walker	25/09/1980	15.95	11.03	8.12	13.22	19.15
212054	Coxs River at Wallerawang	18/01/1992	12.53	11.56	8.15	7.67	15.67

Flows in the Coxs River at Bathurst (monitor 212008) during the current audit period were significantly higher than the long-term average (median 23.93 ML/day vs long term median 13.86 ML/day) and significantly higher than the last three audit periods. During the current audit period, the high flows were more frequent than every day recorded flows compared to 2004-2007 audit where 3% of the data set returned no recorded flows.

Flows in the Coxs River upstream of Lake Lyell (monitor 212058) were also higher than the long-term average for the current audit period (median 34.62 ML/day vs. long-term 20.56 ML/day) and shows a general trend of increase in flows across the audit periods assessed. The 2007-2010 and 2010-2013 audit periods both included assessment of complete datasets whereas the earlier audits (2001-2004 and 2004-2007) had periods where flows were not recorded.

Flows in Neubecks Creek upstream of Wallerawang (monitor 212055) were significantly higher than the long-term average (median 1.60 ML/day vs. long-term 0.59 ML/day). The general trend across the audit periods assessed was an increase in flows. The other audit periods also had

sections of time where no flows were recorded whereas flow monitor 212055 recorded flows on every day of the current audit period.

Flows in Farmers Creek at Mt Walker (monitor 212042) were higher than the long-term average (median 19.15 ML/day vs. long-term 15.95 ML/day) and shows a general increase in flows across the audit periods with the only dip during the 2004-2007 audit period.

Flows in Coxs River at Wallerawang (monitor 212054) were higher than the long-term average (median 15.67 ML/day vs. long-term 12.53 ML/day). This goes against the general trend of preceding audit periods which recorded a general reduction in flows over the periods. All data audit periods recorded flows on every day with the exception of the 2004-2007 audit period (2% of days with no recorded flows).

Environmental flows

The environmental flows will be subject to change. Provisions are included in the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources that will require Delta Electricity to undertake independent investigations on improved regime of environmental flows for the Coxs River that would provide for a demonstrated improvement in river health. The provisions are similar to the provisions relating to Sydney Water's Manly Dam. Having the same provisions as developing environmental releases for Manly Dam provided consistency across the plan area (NOW, 2011).

No investigations into environmental flow and river health by Delta Electricity were supplied for reference in this audit.

Bulk water transfers

Not applicable.

Catchment water quality

Long-term water quality monitoring in the Upper Coxs River sub-catchment is undertaken by the SCA at Farmers Creek (Site E046 – in the upper reaches of the Coxs River upstream of Lake Lyell and downstream of the Lithgow Sewage Treatment Plant).

- For E046, during the current audit period, the median TN concentration was 1.940 mg/L; 95% of samples exceeded the ANZECC guideline for upland rivers. This median TN concentration was within the range of concentrations detected in previous audits (median values for previous three audits ranged from 1.900 to 2.700 mg/L). However, a significant long-term trend was detected with concentrations decreasing by 0.122 mg/L per year.
- During the current audit the median TP concentration for E046 was 0.080 mg/L; 95% of recordings exceeded the ANZECC guideline for upland rivers. The median TP concentration during the current audit was noticeably lower than the range of values recorded for Farmers Creek near Lake Lyell in previous audits (median values for previous three audits ranged from 0.115 to 2.000 mg/L). A significant long-term trend was detected with concentrations decreasing by 0.030 mg/L per year.
- The median electrical conductivity for E046 was 0.210 mS/cm during the current audit; 11% of recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was within the range of values recorded for Farmers Creek near Lake Lyell in previous audits (median values for four previous audits ranged from 0.205 to 0.281 mS/cm). There was a significant long-term trend with conductivity decreasing by 0.027 mS/cm per year.

- The median chlorophyll à concentration for E046 was 3.2 µg/L during the current audit; 36% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. No chlorophyll à results were presented in the previous audit so comparisons to previous audit periods could not be made. Despite this, a trend analyses was carried out and a significant long-term trend was detected with concentrations decreasing by 0.47 µg/L per year.

Storage water quality

Not Available

1.3 Mid Coxs River

1.3.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Mid Coxs River sub-catchment are shown Figure I 1-6.

The main ALUM7 land use class in the Mid Coxs River sub-catchment is Conservation and Natural Environments (61.4%) which is comprised of the tertiary classes of Nature conservation (36.6%) and Other minimal use (25.8%). The secondary land use class is Production from Dryland Agriculture and Plantations (29.0%) of which the key tertiary class is Grazing modified pastures (26.5%) followed by Plantation forestry (2.4%) however Production forestry (4.6%) is also included in the class of Production from Relatively Natural Environments. Intensive Uses makes up a relatively small cover (3.9%) which is primarily Residential and farm infrastructure (3.2%).

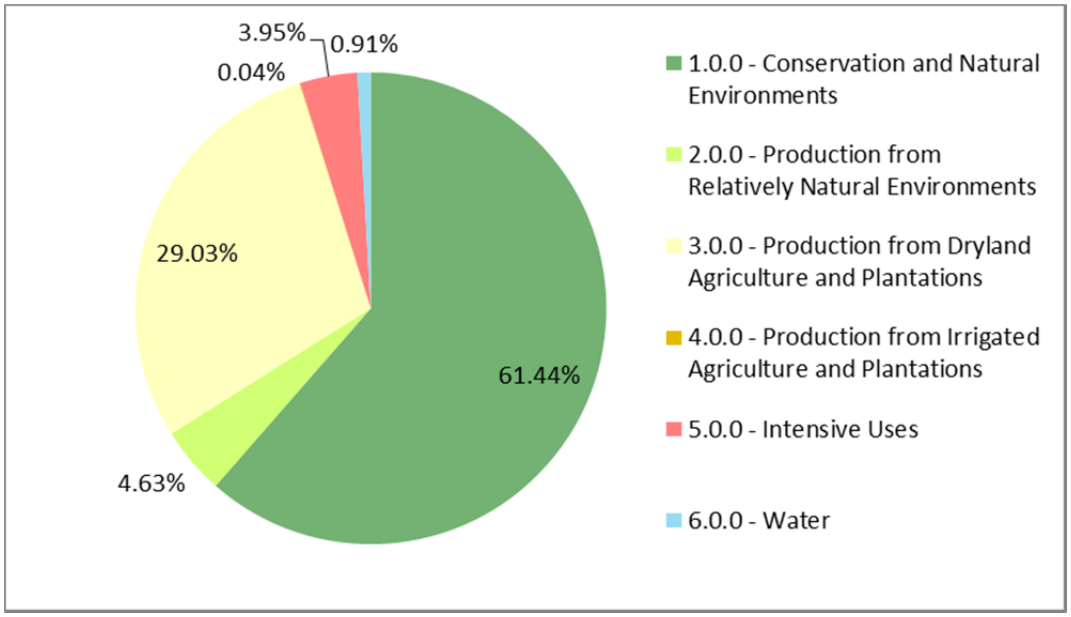


Figure I 1-6 Land use in the Mid Coxs River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Mid Coxs River sub-catchment were primarily sourced from the SCA, and OEH macroinvertebrate monitoring programs. The results are summarised in Figure I 1-7, Figure I 1-8, Figure I 1-9 and Table I 1-4.

A total of 45 sites have been sampled in the Mid Coxs River sub-catchment and a total of 93 macroinvertebrate samples have been collected including historic samples, and all sample data provided by SCA and OEH.

The majority (50.5%) of these samples were rated by AUSRIVAS as reference condition (band A) with the remaining samples rated as significantly impaired (band B) (38.9%), more biologically diverse than reference (band X) (7.6%) or severely impaired (band C) (3.0%).

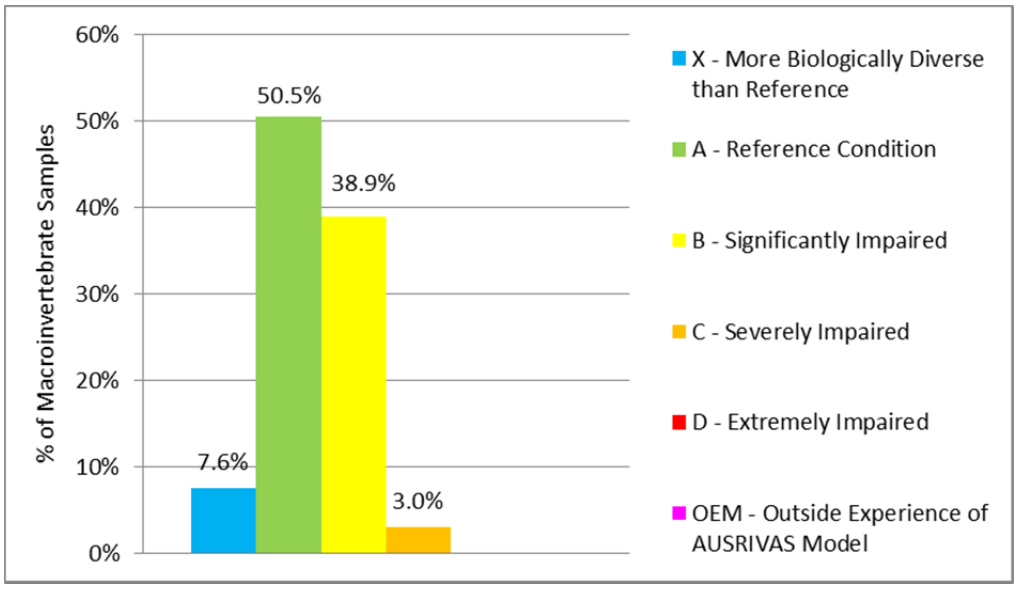


Figure I 1-7 Distribution of AUSRIVAS Bands for all macroinvertebrate sample data provided for the Mid Coxs River sub-catchment

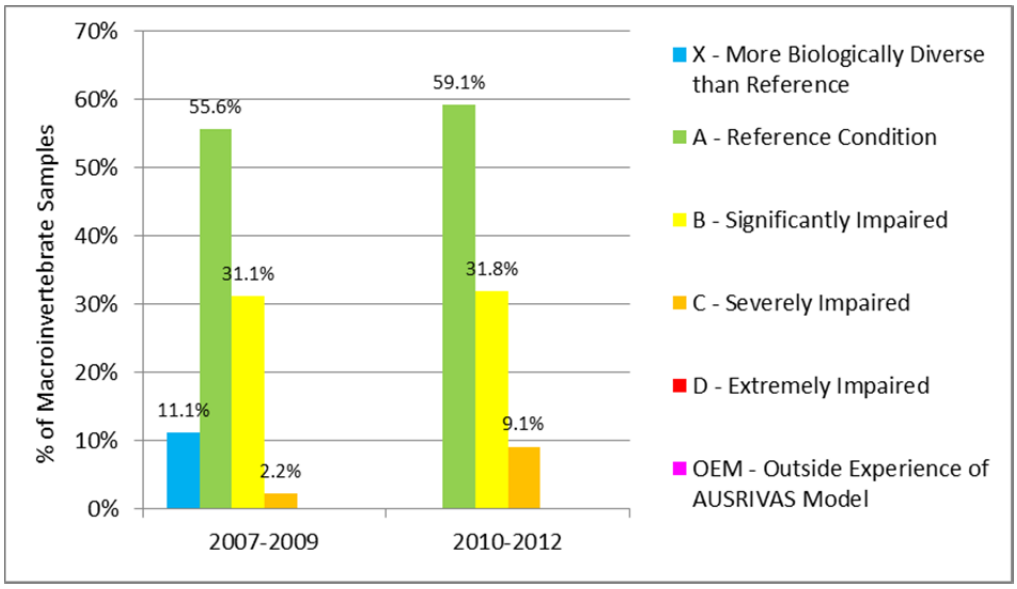
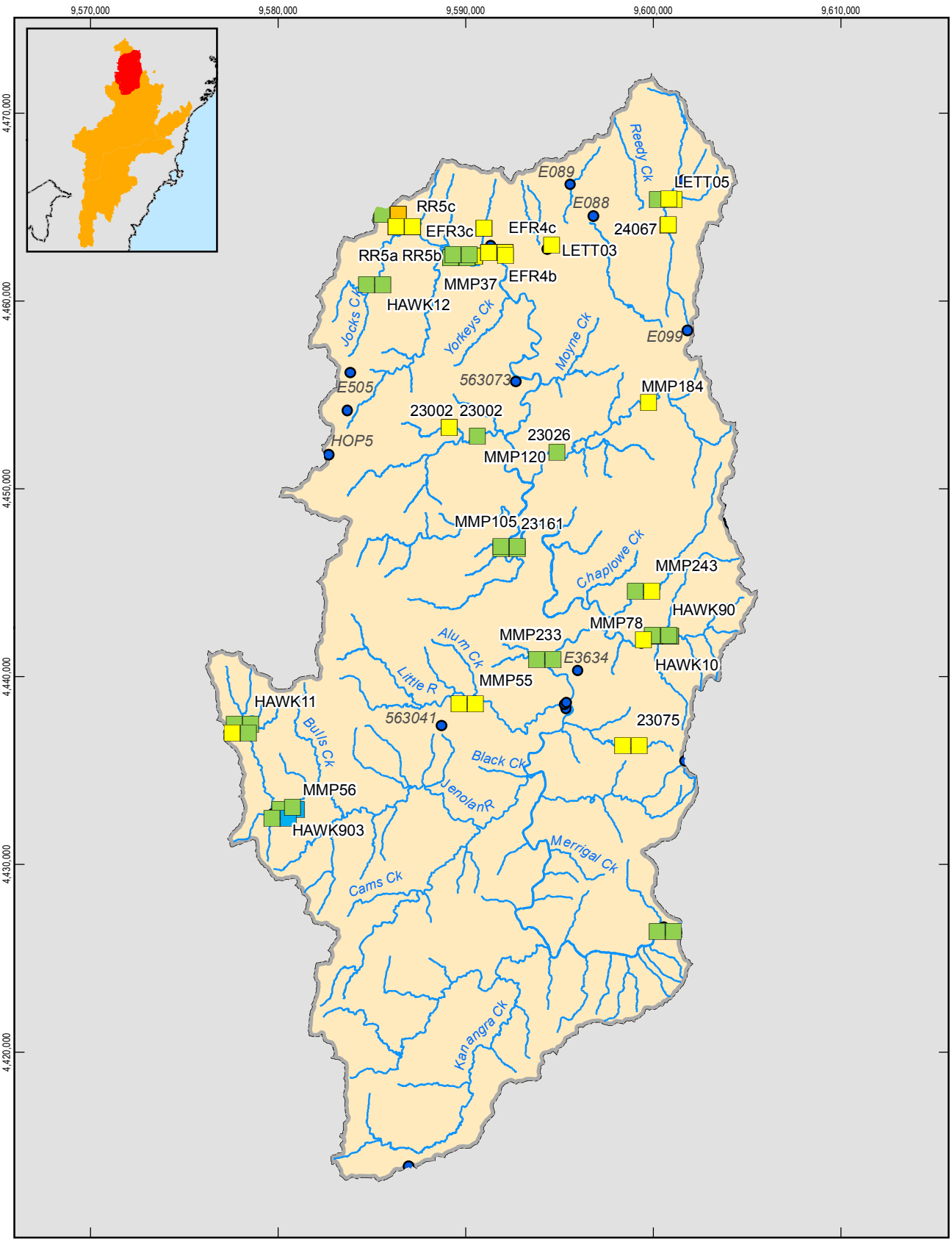


Figure I 1-8 Comparison of AUSRIVAS results from the Mid Coxs River sub-catchment: 2007-09 to 2010-12

Three long-term SCA macroinvertebrate monitoring sites (E086, MMP55 and MMP37) have been consistently sampled since 2001, and macroinvertebrate sample data exists for an additional 44 sites which have been sampled at least once. Seven sites have been sampled during this audit period with the majority (13) of these samples assessed by AUSRIVAS as reference condition (band A). Analysis of results of the long term monitoring sites shows all three sites to fluctuate over time but results of the most recent sampling event show the majority of samples from these sites to be assessed as reference condition (band A).

Comparison of AUSRIVAS results from the previous audit period to those of the current Audit show a slight net decrease in condition (Figure I 1-8) even though there was an increase in sites assessed as reference condition no sites were assessed as more biological diverse than reference (band X) from 2010 to 2012.



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model

- *Water Quality Monitoring Site*
- Waterbody
- Waterway
- Sub-catchment Boundary
- Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Sydney Catchment Authority
Catchment Audit 2013

Mid Coxs River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number 2314960
Revision 0
Date 26 Nov 2013

Figure I1-9

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Level 6, 20 Smith Street Parramatta NSW 2150 Australia T 61 2 8898 8800 F 61 2 8898 8810 E ptamail@ghd.com W www.ghd.com

Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

Table I 1-4 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Mid Coxs River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
23002	Edge	-33.63292	150.11964								A					
23002	Edge	-33.63292	150.11964								B					
23026	Edge	-33.64308	150.18192								A					
23075	Edge	-33.78279	150.23077										B			
23075	Riffle	-33.78279	150.23077										B			
23161	Edge	-33.69007	150.15714									A	A			
23161	Riffle	-33.69007	150.15714										A			
24038	Edge	-33.53663	150.13615										A			
24038	Edge	-33.53663	150.13615										B			
24067	Edge	-33.52017	150.24098										A			
24067	Riffle	-33.52017	150.24098										B			
E086	Edge	-33.87166	150.2538		X	A	A	A	A	A	B	A	A	A	C	A
E086	Riffle	-33.87166	150.2538				A	A	X	A	X	X	A	A	C	A
EFR2a	Edge	-33.531378	150.082992			A	A	B								
EFR2a	Riffle	-33.531378	150.082992			B	C	B								
EFR2b	Edge	-33.531378	150.082992			B	B	A								
EFR2b	Riffle	-33.531378	150.082992			C	B	B								
EFR2c	Edge	-33.531378	150.082992			B	B	A								
EFR2c	Riffle	-33.531378	150.082992			B	B	C								
EFR3a	Edge	-33.550458	150.127562			B	A	B								
EFR3a	Riffle	-33.550458	150.127562			A	B	B								
EFR3b	Edge	-33.550458	150.127562			A	A	B								
EFR3b	Riffle	-33.550458	150.127562			B	B	B								
EFR3c	Edge	-33.550458	150.127562			B	B	A								
EFR3c	Riffle	-33.550458	150.127562			B	B	B								

Table I 1-4 (cont.) AUSRIVAS ranking of macroinvertebrate monitoring sites in the Mid Coxs River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
EFR4a	Edge	-33.548148	150.144871			B	A	B								
EFR4a	Riffle	-33.548148	150.144871			B	A	B								
EFR4b	Edge	-33.548148	150.144871			B	A	B								
EFR4b	Riffle	-33.548148	150.144871			A	B	B								
EFR4c	Edge	-33.548148	150.144871			B	A	B								
EFR4c	Riffle	-33.548148	150.144871			B	B	B								
HAWK10	Edge	-33.72987	150.24684							A						
HAWK10	Edge	-33.72987	150.24684	A						A	B		A			
HAWK10	Riffle	-33.72987	150.24684	A						A	B		A			
HAWK11	Edge	-33.7782	150.0066	A												
HAWK11	Riffle	-33.7782	150.0066	A												
HAWK12	Edge	-33.5653	150.0754	A												
HAWK12	Riffle	-33.5653	150.0754	A												
HAWK864	Edge	-33.5511	150.1232							X	A				A	
HAWK864	Edge	-33.5511	150.1232	A						X	A		A		A	
HAWK864	Riffle	-33.5511	150.1232	X						B			B		A	
HAWK90	Edge	-33.7296	150.2457	A												
HAWK90	Riffle	-33.7296	150.2457	A												
HAWK901	Edge	-33.7826	150.0054	B												
HAWK901	Riffle	-33.7826	150.0054	A												
HAWK902	Edge	-33.8185	150.0344	A												
HAWK902	Riffle	-33.8185	150.0344	X												
HAWK903	Edge	-33.8229	150.0299	A												
HAWK903	Riffle	-33.8229	150.0299	X												
LETT02	Edge	-33.53239	150.24174										C			
LETT03	Edge	-33.54369	150.17546										B			
LETT04	Edge	-33.54928	150.14917										B			

Table I 1-4 (cont.) AUSRIVAS ranking of macroinvertebrate monitoring sites in the Mid Coxs River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
LETT05	Edge	-33.51985	150.24179										B			
MMP105	Edge	-33.68928	150.15709					A								
MMP105	Riffle	-33.68928	150.15709					A								
MMP118	Edge	-33.53227	150.24188						B							
MMP120	Edge	-33.63652	150.1359						A							
MMP184	Edge	-33.61808	150.23378							B						
MMP233	Edge	-33.74308	150.17974								A					
MMP233	Riffle	-33.74308	150.17974								A					
MMP243	Edge	-33.7086	150.2352									A				
MMP243	Riffle	-33.7086	150.2352									B				
MMP37	Edge	-33.54952	150.12444		A	A	A	A	A	X	A	X	X	B	A	A
MMP37	Riffle	-33.54952	150.12444				A	A	A	A		A	A	B	A	A
MMP55	Edge	-33.76537	150.13575		X	A	A	A	A	X	A	A	A		A	B
MMP55	Riffle	-33.76537	150.13575				A	A	B	A	A	B	X		A	B
MMP56	Edge	-33.81735	150.03585			A										
MMP78	Edge	-33.73217	150.235				B									
RR5a	Edge	-33.536988	150.091412			A	B	B								
RR5a	Riffle	-33.536988	150.091412			B	B	B								
RR5b	Edge	-33.536988	150.091412			A	A	B								
RR5b	Riffle	-33.536988	150.091412			B	A	B								
RR5c	Edge	-33.536988	150.091412			B	A	B								
RR5c	Riffle	-33.536988	150.091412			B	B	B								
24096	Edge	-33.72367	150.06643												B	
24097	Edge	-33.99169	150.0862												B	
24098a	Edge	-33.5197	150.18545												B	

Water availability

Surface water flow

Flow data from five gauges within the Mid Coxs River sub-catchment was considered under this current audit. The assessment of these gauges is consistent with previous audits. Table I 1-5 identifies the gauges assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-5 Flow (ML/day) at gauging stations in the Mid Coxs River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
212011	Coxs River at Lithgow	28/05/1960	32.14	7.62	7.02	7.83	17.87
212013	Megalong Creek at Narrow Neck	21/11/1968	5.50	2.19	1.44	5.27	10.11
2122512	Coxs River at Glenroy Bridge	01/05/1999	11.81	6.99	7.46	10.68	33.19
212045	Coxs River at Island Hill	02/01/1981	49.85	15.84	12.40	39.65	93.49
212250	Coxs River at Kelpie Point	02/11/1966	169.30	59.61	45.86	120.39	220.91

The Mid Coxs River sub-catchment includes four flow gauges along the Coxs River which are downstream of both Lake Wallace and Lake Lyell (dams constructed in 1978 and 1983 respectively). It is therefore expected that the flow exceedance curves for the audit period (and all recent audit periods) will show different characteristics from the long-term average curves (although this effect becomes less pronounced further downstream of the dams). Flow gauge data for this sub-catchment will therefore be compared against recent audit periods (post-2001) for the purposes of this audit.

Discharge from Lake Lyell, measured on the Coxs River at Lithgow (monitor 212011) during the audit period showed significant increases over the previous audit periods over all parts of the flow frequency spectrum. When compared with all flow data post-2001, the audit period 10% exceedance flows (145 ML/day for the audit period vs 42.8 ML/day for post-2001 data), median flows (18.3 ML/day vs 8.3 ML/day) and 90% exceedance flows (6.6 ML/day vs 5.2 ML/day) all showed marked increases. This trend continues in the Cox River gauges downstream (at Glenroy Bridge (monitor 2122512), Island Hill (monitor 212045) and Kelpie Point (monitor 212250)), suggesting that water availability both upstream and downstream of Lake Lyell was higher during the audit period than in recent years.

Flows in Coxs River at Kelpie Point (monitor 212250) (the furthest downstream gauge on the Cox River upstream of Lake Burragorang) were significantly higher than during other post-2001 records (median 220 ML/day vs 99 ML/day).

Flows in Megalong Creek at Narrow Neck (monitor 212013) during the audit period were higher than the long-term averages. The median flow for the audit period was 10.1 ML/day, compared to the long-term median of 5.5 ML/day. The previous audit period flows were very similar to the long-term average.

Environmental flows

The environmental flows will be subject to change in the Mid Coxs River sub-catchment. Provisions are included in the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources that will require Delta Electricity to undertake independent investigations on improved regime of environmental flows for the Coxs River that would provide for a demonstrated improvement in river health. The provisions are similar to the provisions relating to Sydney Water's Manly Dam. Having the same provisions as developing environmental releases for Manly Dam provided consistency across the plan area (NOW, 2011).

No investigations into environmental flow and river health by Delta Electricity were supplied for reference in this audit.

Catchment water quality

Long-term water quality monitoring in the Mid Coxs River sub-catchment is undertaken by the SCA at Kelpie Point (Site E083 – in the Special Areas surrounding Lake Burragorang in the lower reaches of the Coxs River).

- The median TN concentration for E083 was 0.200 mg/L during the current audit; 28% of recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was similar to previous audits (median values for previous five audits ranged from 0.155 to 0.400 mg/L). A significant long-term trend was detected for TN with concentrations increasing by 0.004 mg/L per year.
- The median TP concentration for E083 during the current audit was 0.014 mg/L; 22% of recordings exceeded the ANZECC guideline for upland rivers. The median TP concentration during the current audit was higher than the previous five audits (median values ranged from 0.007 to 0.012 mg/L). A significant long-term trend was detected for TP although this was only minor with concentrations increasing by <0.001 mg/L per year.
- During the current audit the median electrical conductivity for E083 was 0.163 mS/cm; no recordings exceeded the ANZECC guideline for upland rivers. The median conductivity during the current audit was slightly higher than the previous five audits (median values ranged from 0.103 to 0.141 mS/cm). A significant long-term trend was detected with conductivity increasing by 0.002 mS/cm per year.
- For E083 the median chlorophyll à concentration during the current audit was 2.0 µg/L; 14% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was noticeably higher than previous audits (median values for previous five audits ranged from 0.3 to 0.9 µg/L). A significant long-term trend was detected with chlorophyll à increasing by 0.09 µg/L per year.

Storage water quality

Not available.

1.4 Lower Coxs River

1.4.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Lower Coxs River sub-catchment are shown Figure I 1-10.

The vast majority of the land use in the Lower Coxs River sub-catchment is classes as Conservation and Natural Environments (91.1%) which covers approximately 22,350 ha and is chiefly made up of the tertiary class Nature conservation. Residential and farm infrastructure is the second highest land use cover, which is a tertiary class of the Intensive Uses class, and accounts for approximately 903 ha (3.7%) of the sub-catchment. Water covers approximately 654 (ha) of which the majority, 616 ha (2.5%) is attributed to the north-western arm of Lake Burragorang.

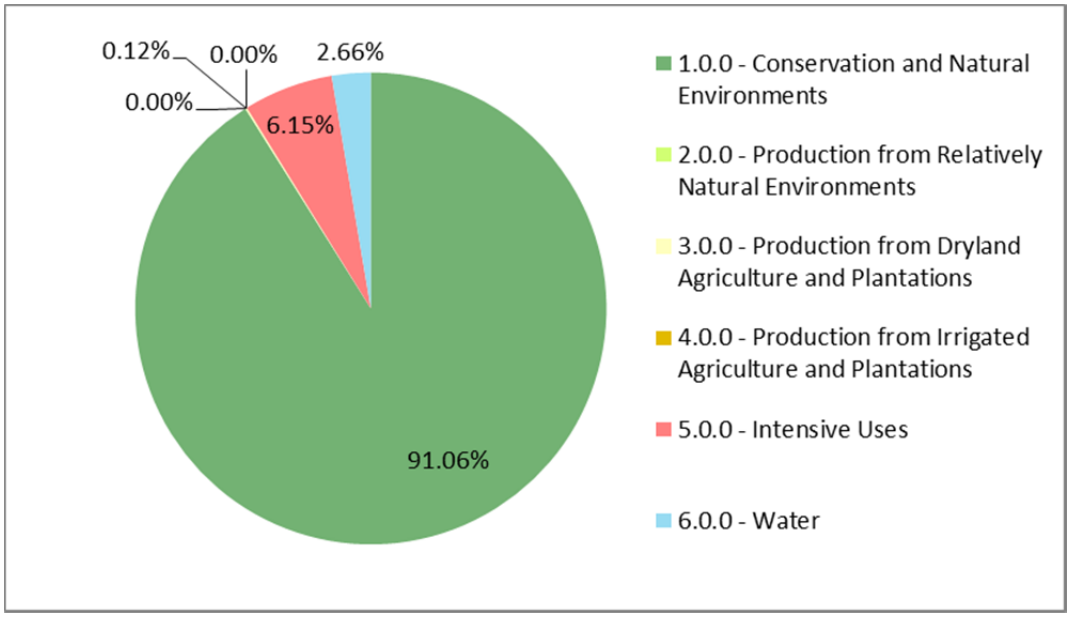


Figure I 1-10 Land use in the Lower Coxs River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Lower Coxs River sub-catchment were primarily sourced from the SCA, and OEH macroinvertebrate monitoring programs. The results are summarised in Figure I 1-11, Figure I 1-12, Figure I 1-13 and Table I 1-6.

A total of 16 sites have been sampled in the Mid Coxs River sub-catchment and macroinvertebrate samples have been collected from a total of 64 samples including historic samples and all sample data provided by SCA and OEH.

The majority (51.6%) of these samples were rated by AUSRIVAS as reference condition (band A) with the remaining samples rated as significantly impaired (band B) (25.0%), more biologically diverse than reference (band X) (10.9%) or severely impaired (band C) (9.4%), with only a few samples (3.1%) falling outside the experience of the AUSRIVAS model.

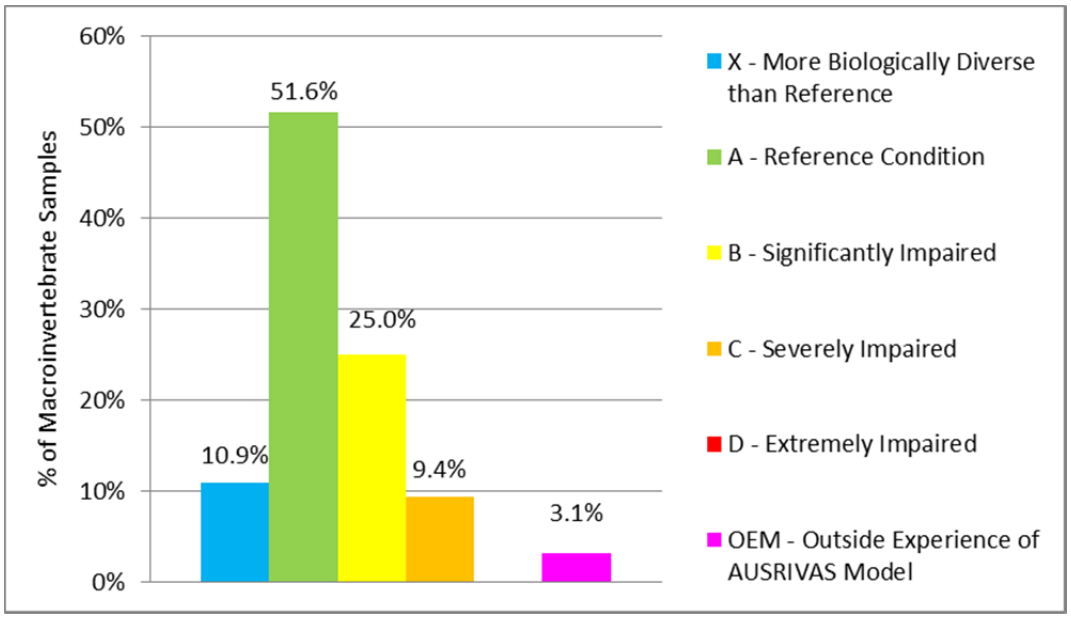


Figure I 1-11 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Lower Coxs River sub-catchment

Two long-term SCA macroinvertebrate monitoring sites (E157 and MMP76) have been consistently sampled since 2001 and while most of these samples were rated as reference condition (band A) both sites fluctuated in condition rating, improving from 2010 to 2011, then declining from 2011 to 2012, and this was consistent for both edge and riffle habitats for both sites. The most recent samples (spring 2012) from both these long-term monitoring sites were assessed as significantly impaired (band B). One other site (22136) was sampled during this audit period (autumn 2011) for which both the edge and riffle samples were rated as significantly impaired (band B).

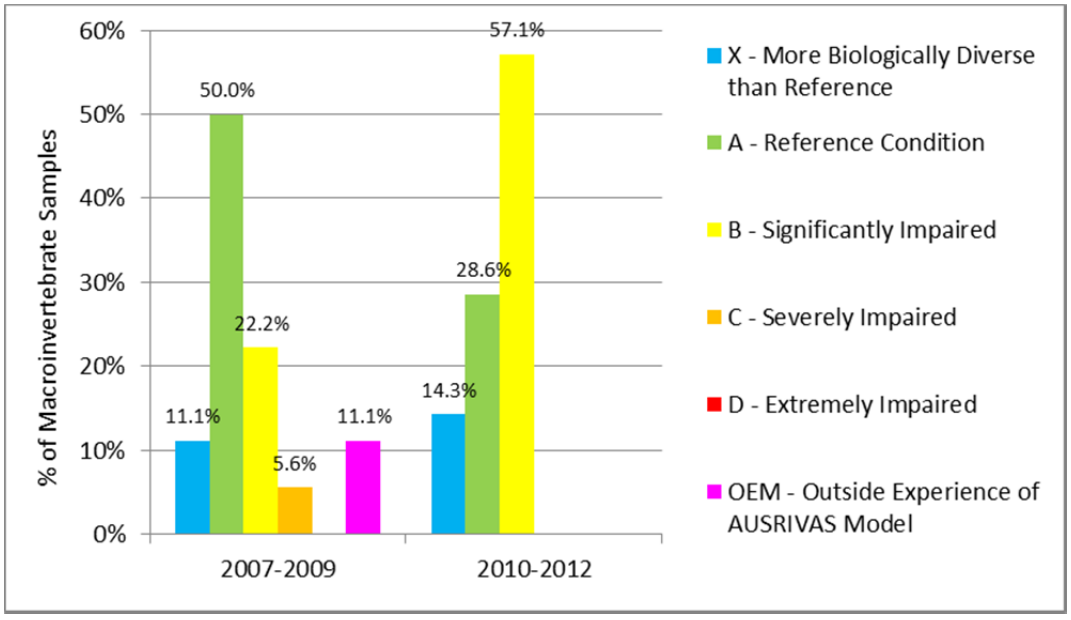
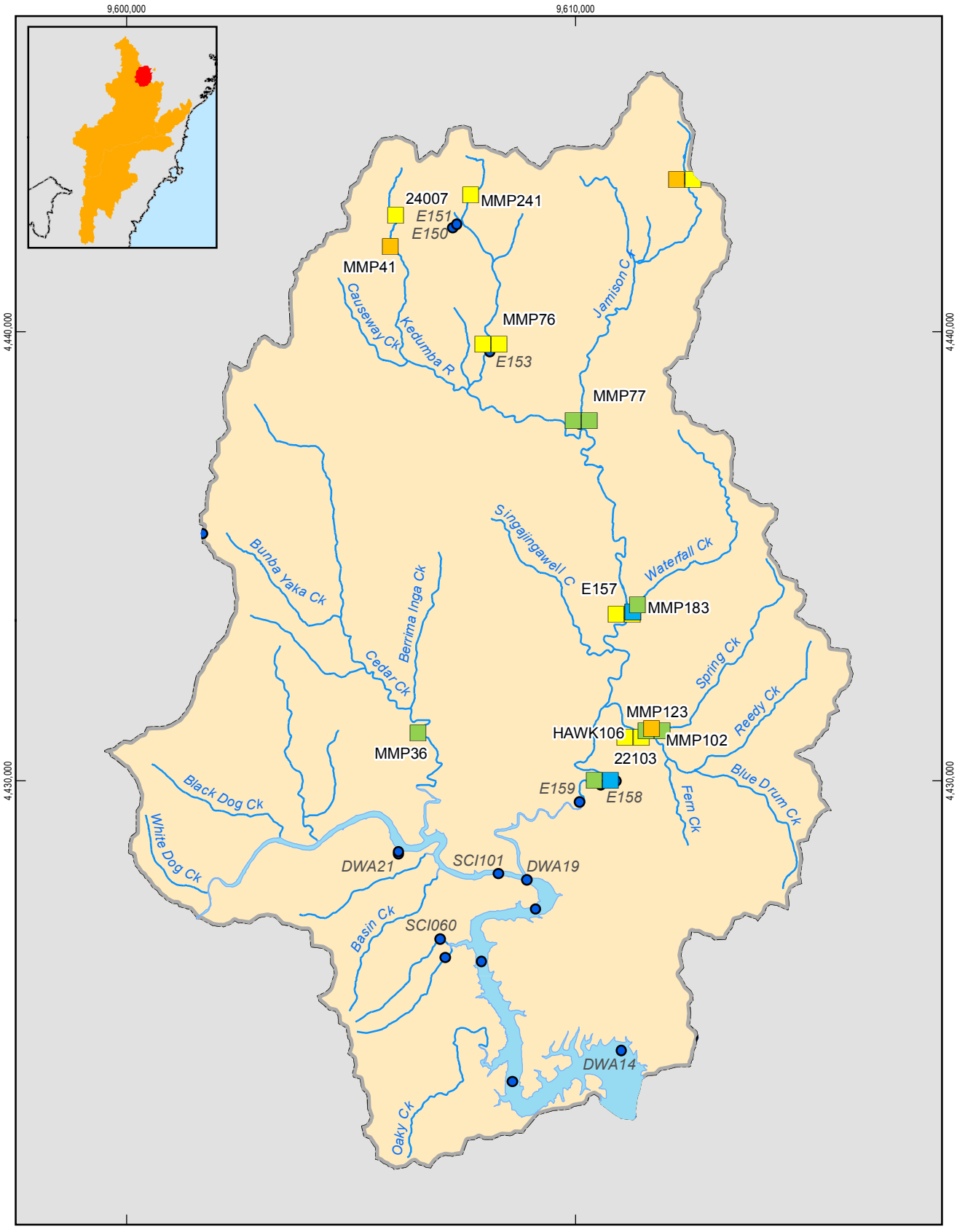


Figure I 1-12 Comparison of AUSRIVAS results from the Lower Coxs River sub-catchment: 2007-09 to 2010-12



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model

- *Water Quality Monitoring Site*
- Waterbody
- Waterway
- Sub-catchment Boundary
- Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

N

Sydney Catchment Authority
Catchment Audit 2013

Lower Coxs River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number 2314960
Revision 0
Date 26 Nov 2013

Figure I1-13

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Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

Table I 1-6 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Lower Coxs River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
22103	Edge	-33.83655	150.3596										A			
22103	Riffle	-33.83655	150.3596										X			
24007	Edge	-33.7244	150.30515								B					
E157	Edge	-33.803	150.36364		A	A	A	A	X	A	A	A	A	A	X	B
E157	Riffle	-33.803	150.36364				A	X	A	A	A	A	X	A	X	B
HAWK106	Edge	-33.8278	150.3667	B												
HAWK106	Riffle	-33.8278	150.3667	B												
HAWK108	Edge	-33.8026	150.3653	C												
HAWK108	Edge	-33.8026	150.3653	X												
MMP102	Edge	-33.8263	150.37167					A								
MMP102	Riffle	-33.8263	150.37167					A								
MMP122	Edge	-33.71529	150.37487						C		C					
MMP122	Riffle	-33.71529	150.37487						B		B					
MMP123	Edge	-33.82587	150.3707							C						
MMP183	Edge	-33.80113	150.36632							A						
MMP241	Edge	-33.71981	150.32306								B					
MMP36	Edge	-33.82823	150.31449			A										
MMP41	Edge	-33.730694	150.304166		C	C										
MMP76	Edge	-33.749722	150.329444				A	B	A	A		A	A	B	A	B
MMP76	Riffle	-33.749722	150.329444					A	A	A		OEM	B	B	A	B
MMP77	Edge	-33.76453	150.35176				A					A				
MMP77	Riffle	-33.76447	150.35186				A					OEM				
22136	Edge	-33.82633	150.37164												B	
22136	Riffle	-33.82633	150.37164												B	

Water availability

Surface water flow

Flow data from one gauge within the Lower Coxs River sub-catchment was considered under this current audit. The assessment of this gauge is consistent with previous audits. Table I 1-7 identifies the gauge assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-7 Flow (ML/day) at gauging stations in the Lower Coxs River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
212016	Kedumba River at Maxwells Crossing	212016	20.00	13.51	12.28	19.85	26.63

Flows in Kedumba Creek at Maxwells Crossing during the audit period (median 26.6 ML/day) were higher than the long-term median (20.0 ML/day). High flows (10% exceedance flow 105 ML/day) and low flows (90% exceedance 66.4 ML/day) during the audit period were also considerably higher than long-term averages (9.7 ML/day and 66.4 ML/day respectively).

Environmental flows

The environmental flows will be subject to change in the Lower Coxs River sub-catchment. Provisions are included in the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources that will require Delta Electricity to undertake independent investigations on improved regime of environmental flows for the Coxs River that would provide for a demonstrated improvement in river health. The provisions are similar to the provisions relating to Sydney Water's Manly Dam. Having the same provisions as developing environmental releases for Manly Dam provided consistency across the plan area. (NOW, 2011)

No investigations into environmental flow and river health by Delta Electricity were supplied for reference in this audit.

Catchment water quality

Long-term water quality monitoring in the Lower Coxs River sub-catchment is undertaken by the SCA in Kedumba Creek at Maxwells Crossing (E157).

- For E157 the median TN concentration during the current audit was 0.300 mg/L; 69% of recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was lower than previous audits (median values for previous five audits ranged from 0.345 to 2.590 mg/L). A significant long-term trend was detected for E157 with concentrations decreasing by 0.011 mg/L per year.
- For E157 the median TP concentration during the current audit was 0.009 mg/L; 6% of recordings exceeded the ANZECC guideline for upland rivers. The median TP concentration during the current audit was lower than previous audits (median values for previous five audits ranged from 0.010 to 0.500 mg/L). A significant long-term trend was

detected although this was only minor with concentrations decreasing by 0.001 mg/L per year.

- During the current audit the median electrical conductivity was 0.084 mS/cm at E157; no recordings exceeded the ANZECC guideline for upland rivers. The median conductivity during the current audit was marginally higher than previous audits (median values for five previous audits ranged from 0.063 to 0.075 mS/cm). There was a significant long-term trend although this was only minor with conductivity increasing by 0.001 mS/cm per year.
- For E157 the median chlorophyll à concentration was 0.5 µg/L during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.4 to 1.1 µg/L). There was no significant long-term trend detected for chlorophyll à at E157.

Storage water quality

Long-term water quality monitoring in the Lower Coxs River sub-catchment was previously undertaken by the SCA at Lake Burragorang (Site DWA19, DWA15 and DWA21). As noted in the previous audit, monitoring ceased at DWA19 and DWA21 in 2004 and only recommenced in 2012. Consequently, there was no data available for the 2004-07 and 2007-10 audit periods. Furthermore, no water quality data were presented for DWA15 in the previous audit.

DWA15 - Lake Burragorang @ Coxs River Arm 4 km u/s Butchers Creek

- For DWA15 the median TN concentration was 0.320 mg/L during the current audit; 29% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. A significant long-term trend was detected with concentrations increasing by 0.100 mg/L per year.
- For DWA15 the median TP concentration was 0.009 mg/L during the current audit; 37% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. A significant long-term trend was detected with concentrations increasing by 0.004 mg/L per year.
- The median electrical conductivity for DWA15 was 0.146 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. A significant long-term trend was detected with conductivity increasing by 0.014 mS/cm per year.
- The median chlorophyll à concentration for DWA15 was 4.7 µg/L during the current audit; 40% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. No significant long-term trend was detected.

DWA19 - Lake Burragorang @ Kedumba River Arm

- The median TN concentration for DWA19 was 0.390 mg/L during the current audit; 65% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was within the range of values recorded in previous audits prior to 2004 (median values for previous three audits ranged from 0.280 to 0.555 mg/L) and no significant long-term trend was detected.
- The median TP concentration for DWA19 was 0.014 mg/L during the current audit; 88% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was similar to the range of values

recorded in previous audits prior to 2004 (median values for previous three audits ranged from 0.010 to 0.014 mg/L) and no significant long-term trend was detected.

- The median electrical conductivity for DWA19 was 0.152 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was slightly higher than the range of values recorded in previous audits (median values for previous three audits ranged from 0.120 to 0.144 mS/cm). A significant long-term trend was detected with conductivity increasing by 0.017 mS/cm per year.
- The median chlorophyll à concentration for DWA19 was 7.4 µg/L during the current audit; 80% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was greater than values recorded in the 1998-2001 and 2001-04 audits (median values 5.8 and 4.4 µg/L respectively) but was less than the median value of 19.5 µg/L recorded in the 1995-98 audit. Despite this, there was no significant long-term trend detected.

DWA21 - Lake Burragorang @ Coxs Arm 37 km u/s Dam

- For DWA21 the median TN concentration was 0.380 mg/L during the current audit; 77% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was greater than previous audits prior to 2004 (median values for previous three audits ranged from 0.230 to 0.280 mg/L) although no significant long-term trend was detected.
- During the current audit the median TP concentration for DWA21 was 0.015 mg/L; 81% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was slightly greater than previous audits (median values for previous three audits ranged from 0.010 to 0.012 mg/L). No significant long-term trend was detected for TP at DWA21.
- For DWA21 the median electrical conductivity was 0.157 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was slightly higher than previous audits (median values for previous three audits ranged from 0.110 to 0.143 mS/cm). No significant long-term trend was detected for DWA21.
- For DWA21 the median chlorophyll à concentration was 6.9 µg/L during the current audit; 74% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was greater than previous audits prior to 2004 (median values for previous three audits ranged from 2.8 to 4.9 µg/L) although no significant long-term trend was detected.

1.5 Grose River – Blue Mountains Catchments

1.5.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Grose River sub-catchment are shown Figure I 1-14.

The vast majority of the land use in the Grose River sub-catchment is classed as Conservation and Natural Environments (75%) which covers approximately 1600 ha and is chiefly made up of the tertiary class Nature conservation (65.6%) and Other minimal use (9.5%). Of the Intensive Uses (19.9%) class the tertiary class Residential and farm infrastructure (12.8%) is the chief land use and is second highest land use cover of the sub-catchment.

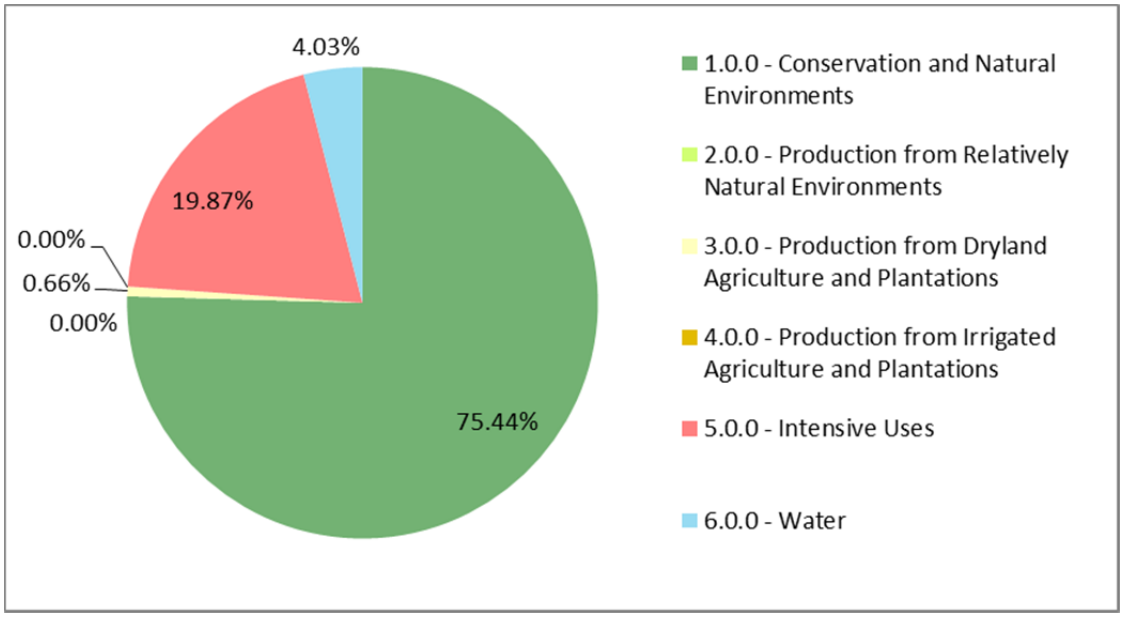


Figure I 1-14 Land use in the Grose River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Grose River sub-catchment were sourced from the SCA macroinvertebrate monitoring program. The results are summarised in Figure I 1-15, Figure I 1-16, Figure I 1-17 and Table I 1-8.

Eight sites have been sampled in the Grose River sub-catchment and a total of 36 macroinvertebrate samples have been collected including historic samples and all sample data provided by SCA.

The majority (52.8%) of these samples were rated by AUSRIVAS as significantly impaired (band B) with the remaining samples rated as reference condition (band A) (36.1%) and more biologically diverse then reference (band X) (2.6%) or severely impaired (band C) (2.6%), with some samples (5.6%) falling outside the experience of the AUSRIVAS model.

One long-term SCA macroinvertebrate monitoring site (MMP39) has been consistently sampled since 2001. Ten samples from this site were assessed to be significantly impaired (band B) and seven as reference condition (band A). During this audit period this site has fluctuated in

condition improving from 2010 to 2011 then declining from 2011 to 2012 and the most recent result for this site was significantly impaired (band B).

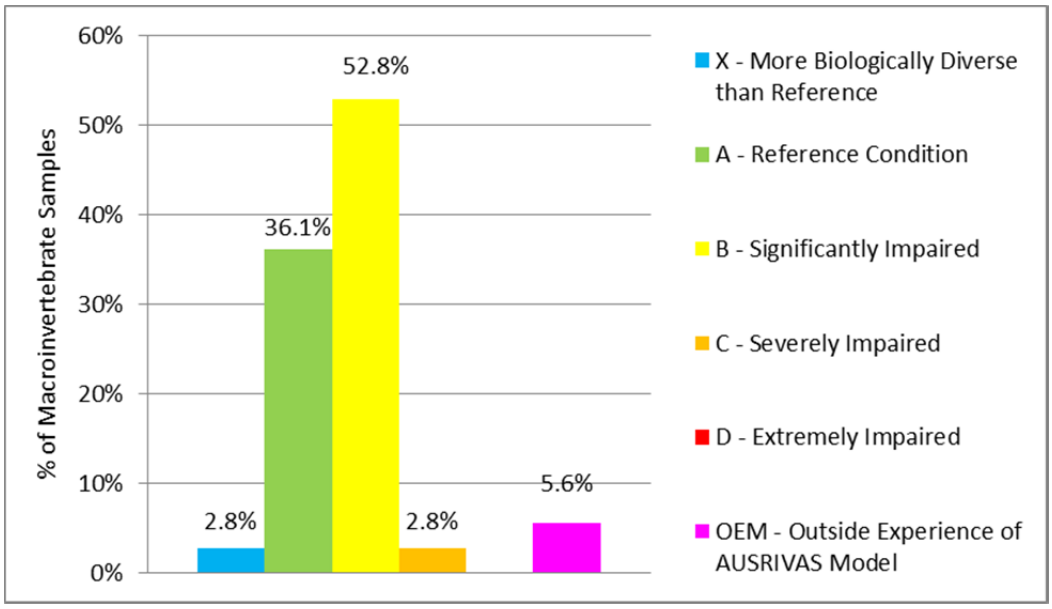


Figure I 1-15 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Grose River sub-catchment

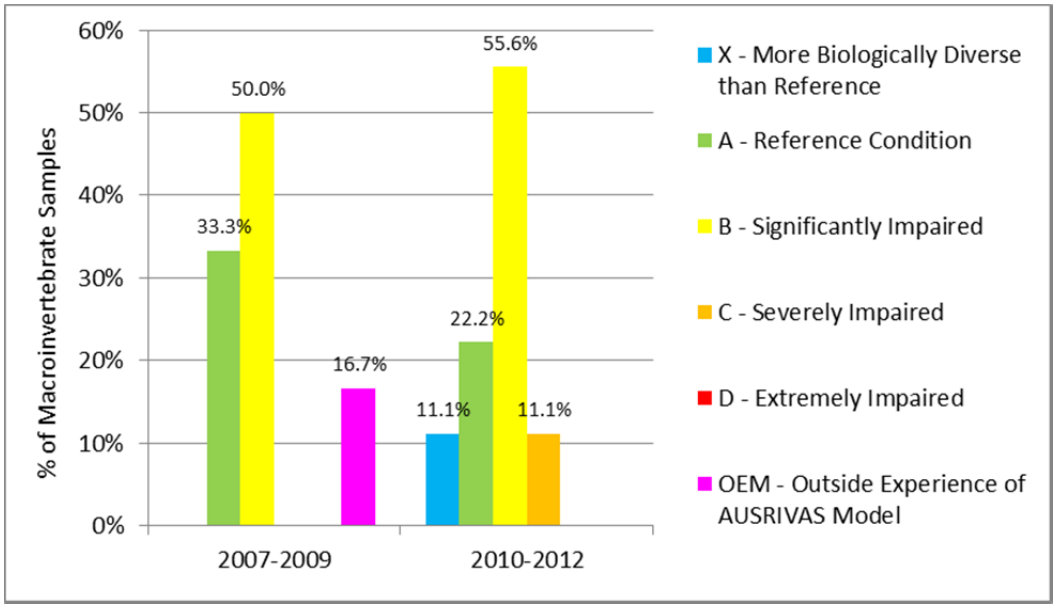
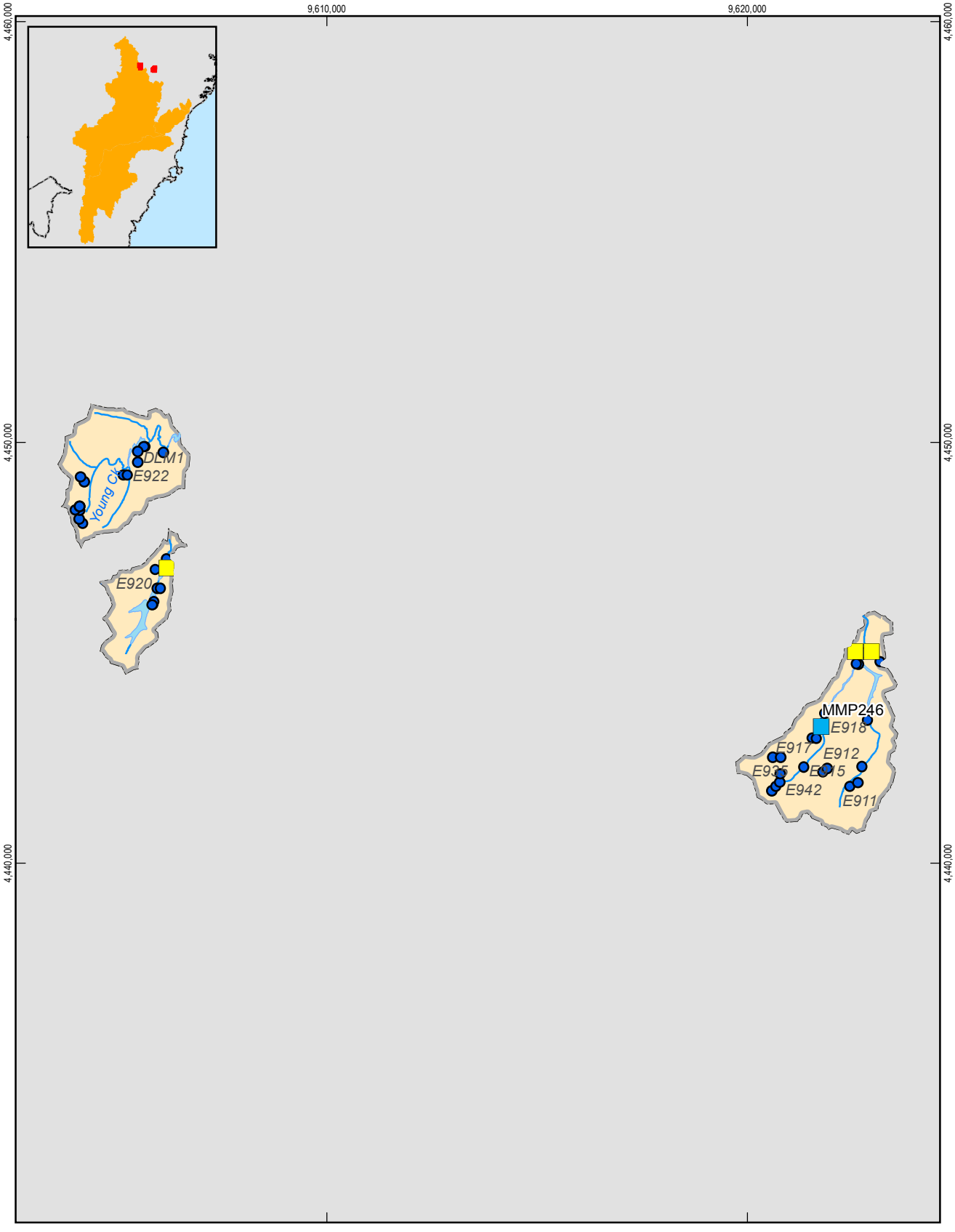


Figure I 1-16 Comparison of AUSRIVAS results from the Grose River sub-catchment: 2007-09 to 2010-12

Four sites were sampled during the most recent sampling event of the audit period (spring 2012) including MMP 246, MMP39, and MMP60. MMP 246 was assessed to be more biologically diverse than reference (band X) while the other samples were assessed as significantly impaired (band B).

Analysis of AUSRIVAS results from the previous audit period compared to the more recent data in 2010 to 2012 shows no clear net change in condition, however the small number of sites limits the overall analysis and no sample data for 2009 has been provided.



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model
- *Water Quality Monitoring Site*
- Waterbody
- Waterway
- Sub-catchment Boundary
- Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Sydney Catchment Authority
Catchment Audit 2013

Grose River - Blue Mts Catchments Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number	2314960
Revision	0
Date	26 Nov 2013

Figure I1-17

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Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

Table I 1-8 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Grose River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
MMP121	Edge	-33.65712	150.3231					B								
MMP121	Riffle	-33.65712	150.3231					A								
MMP177	Edge	-33.68104	150.52681						A							
MMP177	Riffle	-33.68104	150.52681						B							
MMP178	Edge	-33.70775	150.46721							OEM						
MMP246	Edge	-33.68583	150.32626								OEM					X
MMP39	Edge	-33.6974	150.48568	A	B	A	A	B	B	B	A	B		B	A	B
MMP39	Riffle	-33.6974	150.48568					A	B			B		B	A	B
MMP40	Edge	-33.68591	150.32642	A	B	B	A	A	B	B	A	B				
MMP60	Edge	-33.68444	150.30583			dry								C		B

Water availability

Surface water flow

Flow data from one gauge within the Grose River sub-catchment was considered under this current audit. The assessment of this gauge is consistent with previous audits. Table I 1-9 identifies the gauge assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-9 Flow (ML/day) at gauging stations in the Grose River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
212291	Grose River at Burralow	01/11/1987	103.77	68.48	63.95	116.42	191.02

Flow data is not available for the Blue Mountains dam catchments (Greaves Creek, Cascade Creek and Woodford Creek) within the SCA catchment area. Flow data is however available for Grose River at Burralow Creek, approximately 50 km downstream of the three SCA sub-catchments. This gauge shows that flows during the audit period were higher than the historical average and the previous audit period for the full flow exceedance range, in particular for median to high flows. It should be noted however that only a small proportion of the gauge's catchment lies within SCA catchment areas.

Bulk water transfers

Two interbasin transfers involving the Grose River sub-catchment were identified from the data supplied for this audit. Table I 1-10 provides the details of these bulk transfers and also the long term transfers with data taken from previous audit periods.

Table I 1-10 Bulk water transfers in the Grose River sub-catchment

From Reservoir	To Reservoir	Total Volume Transferred (ML)			Median Volume Transferred (ML/day)				Average Volume Transferred (ML/day)			
		2010-13 Audit Period	2007-2010 Audit Period	2004-2007 Audit Period	2010-13 Audit Period	2007-2010 Audit Period	2004-2007 Audit Period	Long Term 2004-2013	2010-13 Audit Period	2007-2010 Audit Period	2004-2007 Audit Period	Long Term 2004-2013
Greaves	Cascades	7,568	5,811	2,989	9	9	0	9	7	5	3	5
Fish River	Cascades	1,162	1,243	6,984	0	0	9	0	1	1	6	3

The bulk water transfer from Greaves to Cascades is within the Grose River sub-catchment. The Fish River water pipeline transfers flows from the Fish River Scheme, originating in Oberon, outside the Grose River sub-catchment.

Table I 1-10 and Figure I 1-18 also provide the long term trend of the bulk water transfer for this sub-catchment.

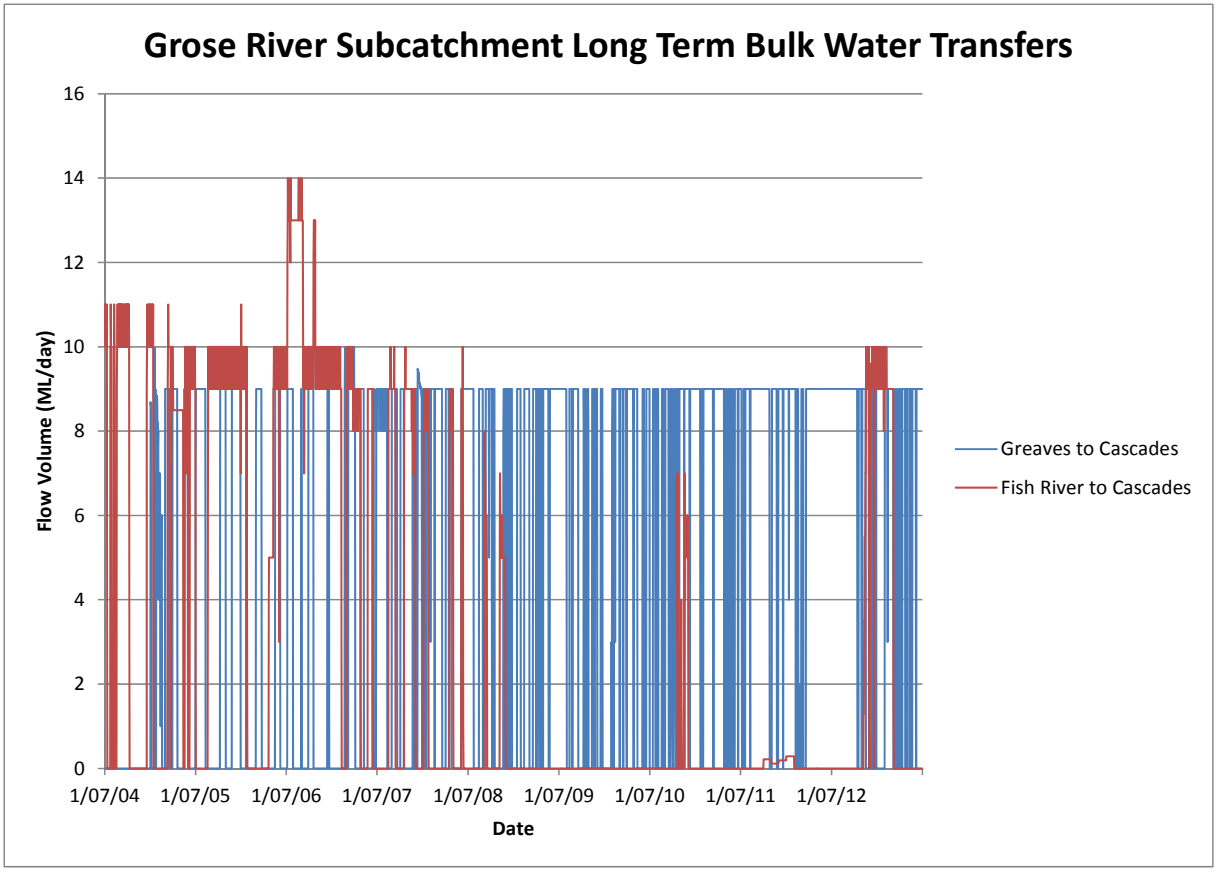


Figure I 1-18 Grose River sub-catchment long term bulk water transfers

From the table and graph, it can be seen that between the audit periods there has been an increase of flows transferred into the Cascades Reservoir from the Greaves reservoir and a decrease in flows from the Fish River Water transfer pipeline over the three audit periods considered.

Catchment water quality

Not available.

Storage water quality

Long-term water quality monitoring in the Grose River sub-catchment is undertaken by the SCA at the Lower Cascade Dam (DLC1), the Top Cascade Dam (DTC1) and the Greaves Creek Dam (DGC1).

DLC1 - Lower Cascade Dam

- The median TN concentration for DLC1 was 0.160 mg/L during the current audit and no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was lower than values recorded in previous audits (median values for previous five audits ranged from 0.200 to 0.270 mg/L)

and a significant long-term trend was detected with concentrations decreasing by 0.008 mg/L per year.

- The median TP concentration for DLC1 was 0.006 mg/L during the current audit and 20% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was greater than values recorded in previous audits (median values for previous five audits were all 0.005 mg/L). Despite this, no significant long-term trend was detected.
- The median electrical conductivity for DLC1 was 0.072 mS/cm during the current audit and no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was within the range of values recorded in previous audits (median values for previous four audits ranged from 0.065 to 0.073 mS/cm). A significant long-term trend was detected although this was only minor with conductivity increasing by only 0.001 mS/cm per year.
- The median chlorophyll à concentration for DLC1 was 2.3 µg/L during the current audit and 6% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 1.9 to 3.8 µg/L). A significant long-term trend was detected with chlorophyll à increasing by 0.05 µg/L per year.

DTC1 - Top Cascade Dam

- For DTC1 the median TN concentration was 0.140 mg/L during the current audit and 6% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was less than previous audits (median values for previous five audits ranged from 0.175 to 0.360 mg/L) and a significant long-term trend was detected with concentrations decreasing by 0.019 mg/L per year.
- For DTC1 the median TP concentration was 0.006 mg/L during the current audit and 20% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.003 to 0.009 mg/L). Although a significant long-term trend was detected this was only minor with concentrations increasing by <0.001 mg/L per year.
- For DTC1 the median electrical conductivity was 0.040 mS/cm during the current audit and no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was slightly lower than previous audits (median values for previous four audits ranged from 0.045 to 0.067 mS/cm). Although a significant long-term trend was detected this was only minor with conductivity decreasing by 0.002 mS/cm per year.
- For DTC1 the median chlorophyll à concentration was 2.9 µg/L during the current audit and 7% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 2.0 to 6.8 µg/L) although no significant long-term trend was detected.

DGC1 - Greaves Creek Dam

- The median TN concentration for DGC1 was 0.130 mg/L during the current audit and no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was generally less than previous audits (median values for previous five audits ranged from 0.130 to 0.225 mg/L) and a significant long-term trend was detected with concentrations decreasing by 0.005 mg/L per year.
- The median TP concentration for DGC1 was 0.009 mg/L during the current audit and 40% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was greater than previous audits (median values for previous five audits ranged from 0.005 to 0.006 mg/L) and although a significant long-term trend was detected this was again only minor with concentrations increasing by <0.001 mg/L per year.
- The median electrical conductivity for DGC1 was 0.018 mS/cm during the current audit and no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was again slightly less than previous audits (median values for previous four audits ranged from 0.019 to 0.036 mS/cm). A significant long-term trend was detected although this was again only minor with conductivity decreasing by <0.001 mS/cm per year.
- The median chlorophyll à concentration for DGC1 was 2.1 µg/L during the current audit and 5% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was again within the range of values recorded in previous audits (median values for previous five audits ranged from 1.9 to 4.7 µg/L). A significant long-term trend was detected with concentrations decreasing by 0.05 µg/L per year.

1.6 Kowmung River

1.6.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Kowmung River sub-catchment are shown Figure I 1-19.

The majority of the land use cover in the Kowmung River sub-catchment is classed as Conservation and Natural Environments (77.5%) which covers approximately 56,925 ha and is chiefly made up of the tertiary class Nature conservation (74.2%). Production from Dryland Agriculture and Plantations (20.9%) is the second most extensive cover in the Kowmung River sub-catchment and this is predominantly contributed to the tertiary class Grazing modified environments(11.6%) and Plantation forestry (8.9%).

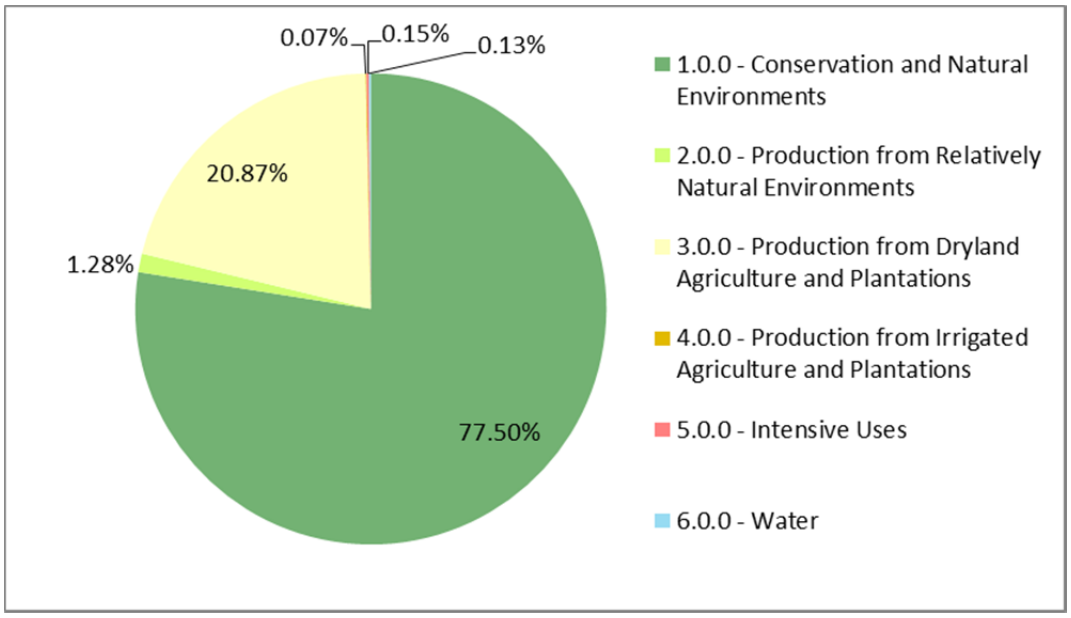


Figure I 1-19 Land use in the Kowmung River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Kowmung River sub-catchment were sourced from SCA and OEH macroinvertebrate monitoring programs. The results are summarised in Figure I 1-20, Figure I 1-21, Figure I 1-22 and Table I 1-11.

Nineteen sites have been sampled in the Kowmung River sub-catchment and a total of 68 macroinvertebrate samples have been collected including historic samples and all sample data provided by SCA and OEH.

The majority (60.3%) of these samples received an AUSRIVAS assessment of reference condition (band A) with the remaining samples rated as significantly impaired (band B) (19.1%), more biologically diverse than reference (band X) (16.2%) or severely impaired (band C) (2.9%), with only one sample (1.5%) falling outside the experience of the AUSRIVAS model.

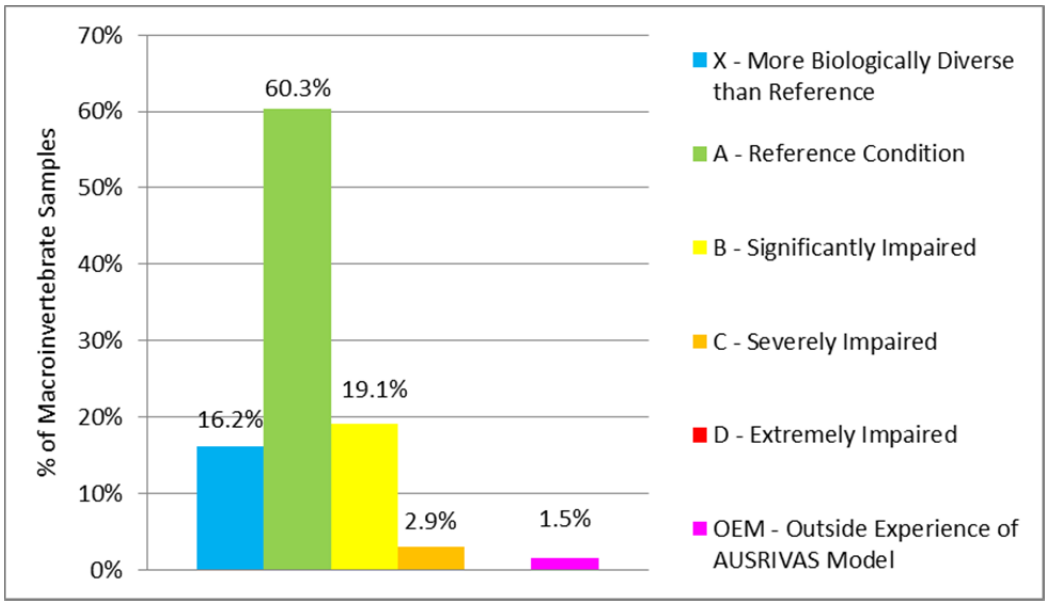


Figure I 1-20 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Kowmung River sub-catchment

Two long-term SCA macroinvertebrate monitoring sites (E130 and MMP14) have been consistently sampled since 2001 and both sites have had consistent riffle and edge habitats available for sampling. The majority of samples (31) from these sites were assessed to be reference condition (band A), with some also assessed as more biologically diverse than reference (band X) (10 samples) or significantly impaired (band B) (5 samples).

These two long term monitoring sites were also sampled during this audit period. All samples from E130 from spring 2010 to spring 2012 were assessed to be reference condition (band A) while MMP14 declined from band A in 2010 to band B in 2011 and then recovered to band X in 2012. Two additional sites were also sampled by OEH in autumn 2011, both of which had edge only and both were assessed as significantly impaired (band B).

Analysis of AUSRIVAS results for the previous audit period compared to data provided for the 2010 to 2012 period (Figure I 1-21) shows no clear net change in condition across the Kowmung River sub-catchment. While there was a decrease in sites assessed as more biologically diverse then reference (band X) there was also an decrease in number of sites assessed as severely impaired, and an increase in both reference condition (band A) and significantly impaired (band B) assessed sites.

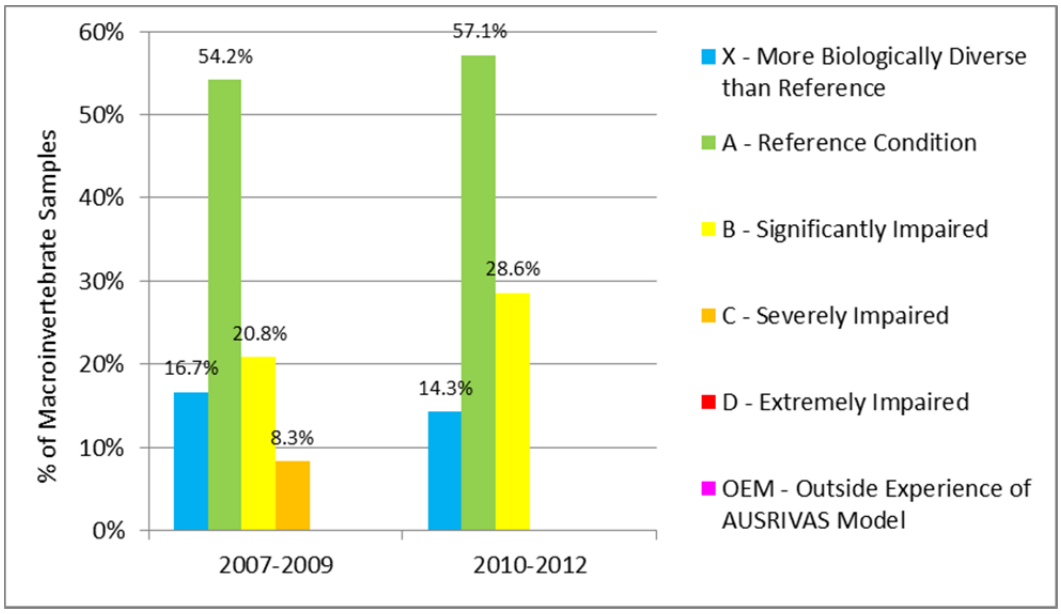
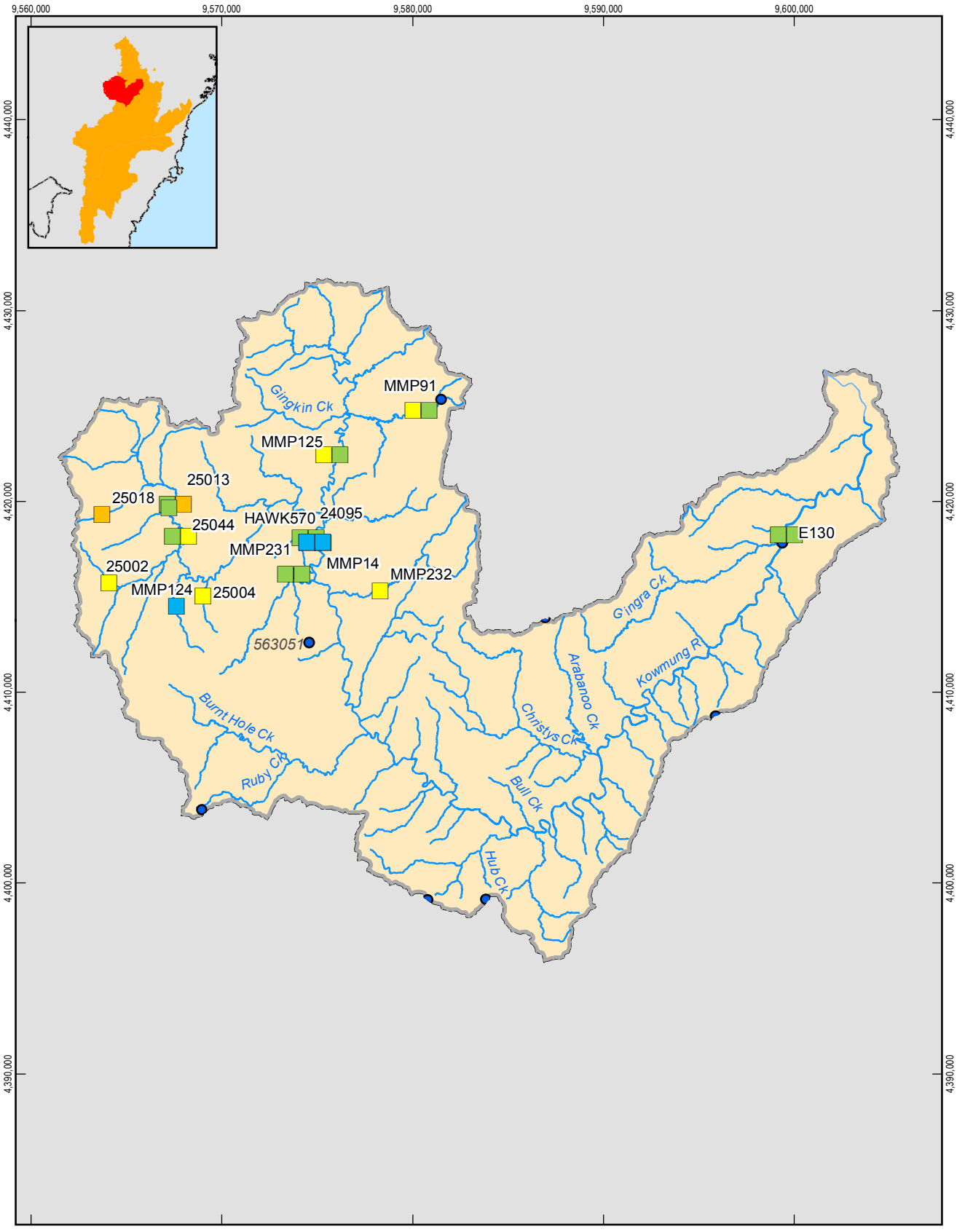


Figure I 1-21 Comparison of AUSRIVAS results from the Kowmung River sub-catchment: 2007-09 to 2010-12



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model
- *Water Quality Monitoring Site*
- Waterbody
- Waterway
- Sub-catchment Boundary
- Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Sydney Catchment Authority
Catchment Audit 2013

Kowmung River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number	2314960
Revision	0
Date	26 Nov 2013

Figure I1-22

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Table I 1-11 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Kowmung River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
24095	Edge	-33.95392	149.97383										A			
24095	Riffle	-33.95392	149.97383										A			
25002	Edge	-33.97788	149.86053								B					
25004	Edge	-33.98297	149.91413								B					
25013	Edge	-33.9398	149.89787								A					
25013	Riffle	-33.9398	149.89787								C					
25018	Edge	-33.94556	149.85565										C			
25044	Edge	-33.95489	149.90134										A			
25044	Riffle	-33.95489	149.90134										B			
25045	Edge	-33.918	149.87487												B	
25056	Edge	-33.94569	149.89394												B	
E130	Edge	-33.94568	150.24529	A	fires	A	A	A	X	A	A	B	A	A	A	A
E130	Riffle	-33.94568	150.24529	A	fires	A	A	A	A	A	X	A	X	A	A	A
HAWK570	Edge	-33.9561	149.978	A												
HAWK570	Riffle	-33.9561	149.978	A												
MMP124	Edge	-33.98822	149.89926						X							
MMP125	Edge	-33.9142	149.98592							B						
MMP125	Riffle	-33.9142	149.98592							A						
MMP14	Edge	-33.95586	149.97779		fires	A	B	X	X	X	A	A	X	A	B	X
MMP14	Riffle	-33.95586	149.97779		fires		A	B	A	A	A	X	A	A	B	X
MMP15	Edge	-33.941574	149.8935		A	OEM										
MMP231	Edge	-33.97124	149.96641								A					
MMP231	Riffle	-33.97124	149.96641								A					
MMP232	Edge	-33.9779	150.01469									B				
MMP74	Edge	-33.9389	149.9424													
MMP91	Edge	-33.89216	150.03585					B								
MMP91	Riffle	-33.89216	150.03585					A								

Water availability

Surface water flow

Flow data from one gauge within the Kowmung River sub-catchment was considered under this current audit. The assessment of this gauge is consistent with previous audits. Table I 1-12 identifies the gauge assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-12 Flow (ML/day) at gauging stations in the Kowmung River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
212260	Kowmung River at Cedar Ford	01/05/1968	134.88	56.16	38.46	118.83	242.84

Flows in the Kowmung River at Cedar Ford during the audit period (median 243 ML/day) were significantly higher than the long-term median (135 ML/day). Flows were higher during the audit period across the full flow exceedance curve, however this is more pronounced at the low-flow end of the spectrum (audit period 90% exceedance flow 79 ML/day vs long-term 21.7 ML/day) than at the high-flow end of the spectrum (audit period 10% exceedance flow 1035 vs long-term 825 ML/day). The trend towards a lower frequency of relatively low and high flows echoes the previous audit period, however the magnitude of flows during the audit period was much higher than the previous audit (median 118 ML/day).

Catchment water quality

SCA at Cedar Ford (Site E130 – approximately 15 km upstream of the Coxs River confluence).

- The median TN concentration for E130 was 0.160 mg/L during the current audit; 19% of recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was lower than for all previous audits (median values for previous five audits ranged from 0.170 to 0.500 mg/L) although no significant long-term trend was detected.
- During the current audit the median TP concentration for E130 was 0.014 mg/L; 11% of recordings above the ANZECC guideline for upland rivers. The median TP concentration during the current audit was slightly higher than previous audits (median values for previous five audits ranged from 0.009 to 0.013 mg/L). A significant long-term trend was detected for TP although this was only minor with concentrations increasing by <0.001 mg/L per year.
- The median electrical conductivity for E130 was 0.077 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for upland rivers. The median conductivity during the current audit was similar to previous audits (median values for five previous five audits ranged from 0.066 to 0.078 mS/cm). There was no significant long-term trend detected for conductivity at E130.

- The median chlorophyll à concentration for E130 was 1.1 µg/L during the current audit and no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.2 to 1.3 µg/L) although a significant trend was detected with concentrations increasing by 0.05 µg/L per year.

Storage water quality

Not available.

1.7 Lake Burragorang

1.7.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Lake Burragorang sub-catchment are shown Figure I 1-23.

The Lake Burragorang sub-catchment is a closed catchment and land use in the majority of the catchment is classed as Conservation and Natural Environments (90.1%) which covers approximately 55,497 ha and is chiefly made up of the tertiary classes Nature conservation (69.2%) and Managed resource protection (18.5%). A considerable proportion of the catchment is also covered by the Lake Burragorang Reservoir (8.2%).

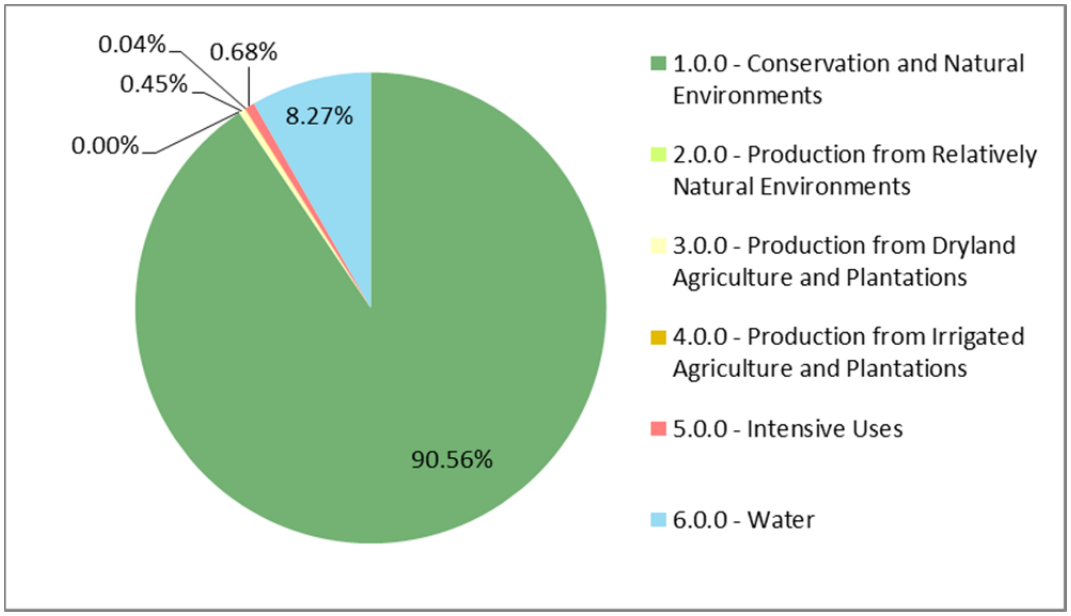


Figure I 1-23 Land use in the Lake Burragorang sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Lake Burragorang sub-catchment were primarily sourced from the SCA macroinvertebrate monitoring program with one additional site sampled by OEH in 2006. The results are summarised in Figure I 1-24, Figure I 1-25 and Table I 1-13.

Nine sites have been sampled in Lake Burragorang sub-catchment and a total of 21 macroinvertebrate samples have been collected including historic samples and all sample data provided by SCA and OEH. The aquatic habitat at the macroinvertebrate monitoring sites was dry on 39.5% of attempted sampling events and historic data also shows that fires prevented sample collection at the two core sites (MMP01 and MMP02).

Where AUSRIVAS samples could be collected results indicate that the majority of macroinvertebrate samples collected from the Lake Burragorang sub-catchment were assessed to be significantly impaired (band B) (57.1%) and the remaining samples were assessed to be reference condition (band A) (42.9%).

Eight samples have been collected during this audit period including seven from edge habitat and one from riffle habitat. One site was sampled in 2010 which was assessed as significantly impaired (band B). Four sites were sampled in 2011 all of which were rated as reference condition (band A) and two sites were sampled in 2012 both of which were assessed as significantly impaired (band B).

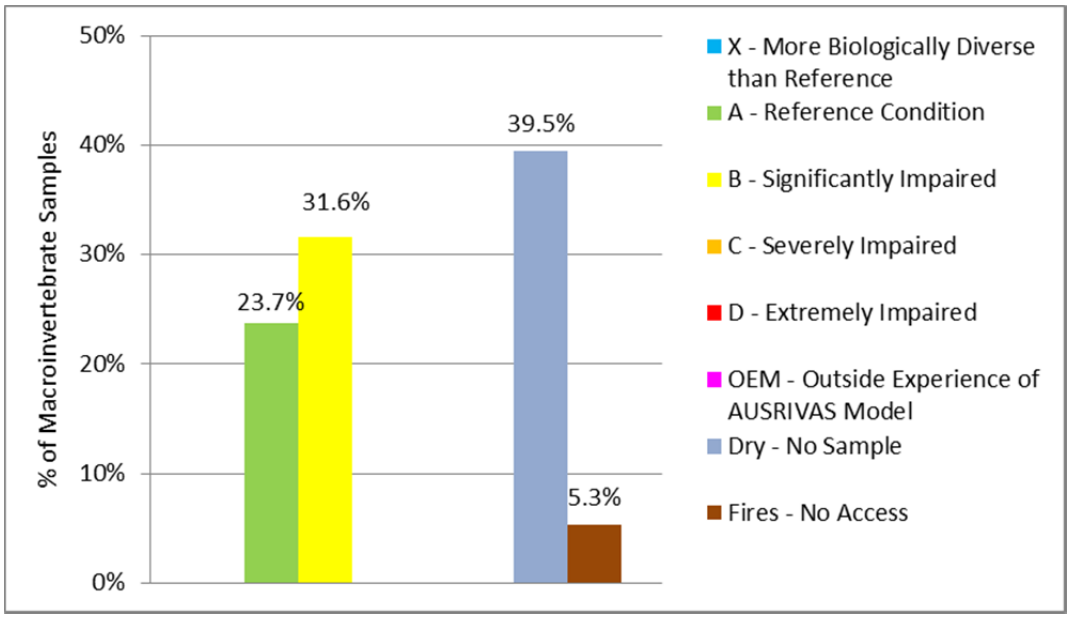


Figure I 1-24 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Lake Burragorang sub-catchment

Analysis of data collected during the previous audit period compare to data provided for the 2010 to 2012 period (Figure I 1-25) shows a general improvement in condition across the Lake Burragorang sub-catchment. This may be due to fluctuation water level of the lake and drying of sample sites during the 2008 sampling event in addition to the lack of sample data for 2009.

The inconsistent nature of aquatic habitat persistence (particularly MMP01) may have a strong influence on the macroinvertebrate community composition and may be an important factor influencing the AUSRIVAS ratings at within the Lake Burragorang sub-catchment. Aquatic habitat at some sites is likely to be influenced by fluctuations in water level of Lake Burragorang. AUSRIVAS assessment of this data may be inappropriate due to the lacustrine nature of the habitat available in the Lake Burragorang sub-catchment and future analysis should consider development of a macroinvertebrate index developed specifically for the Lake Burragorang and similar lake and reservoir catchments.

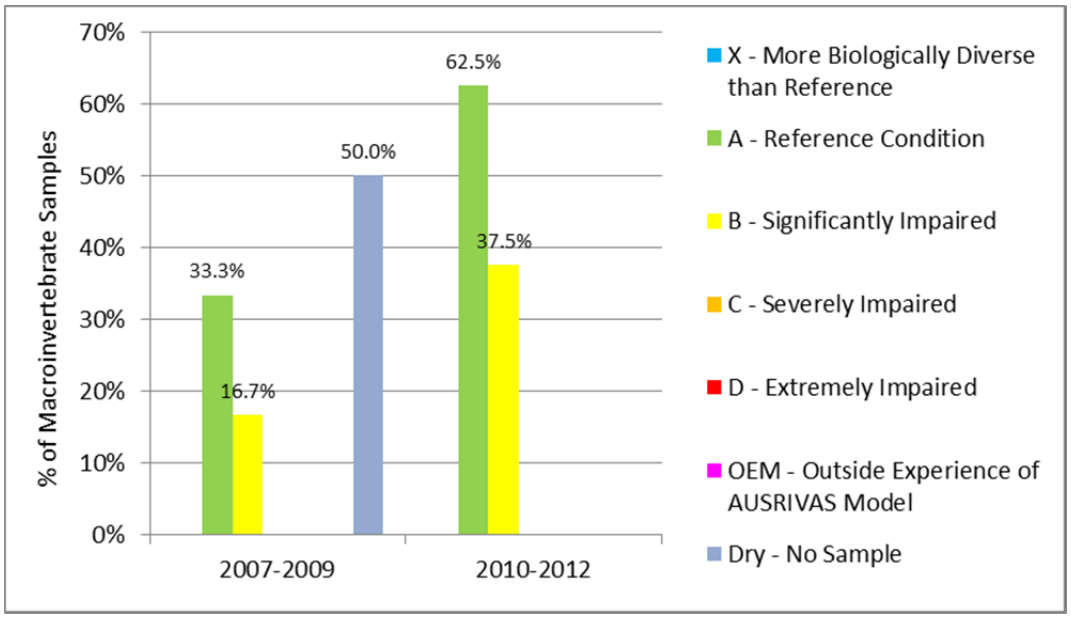
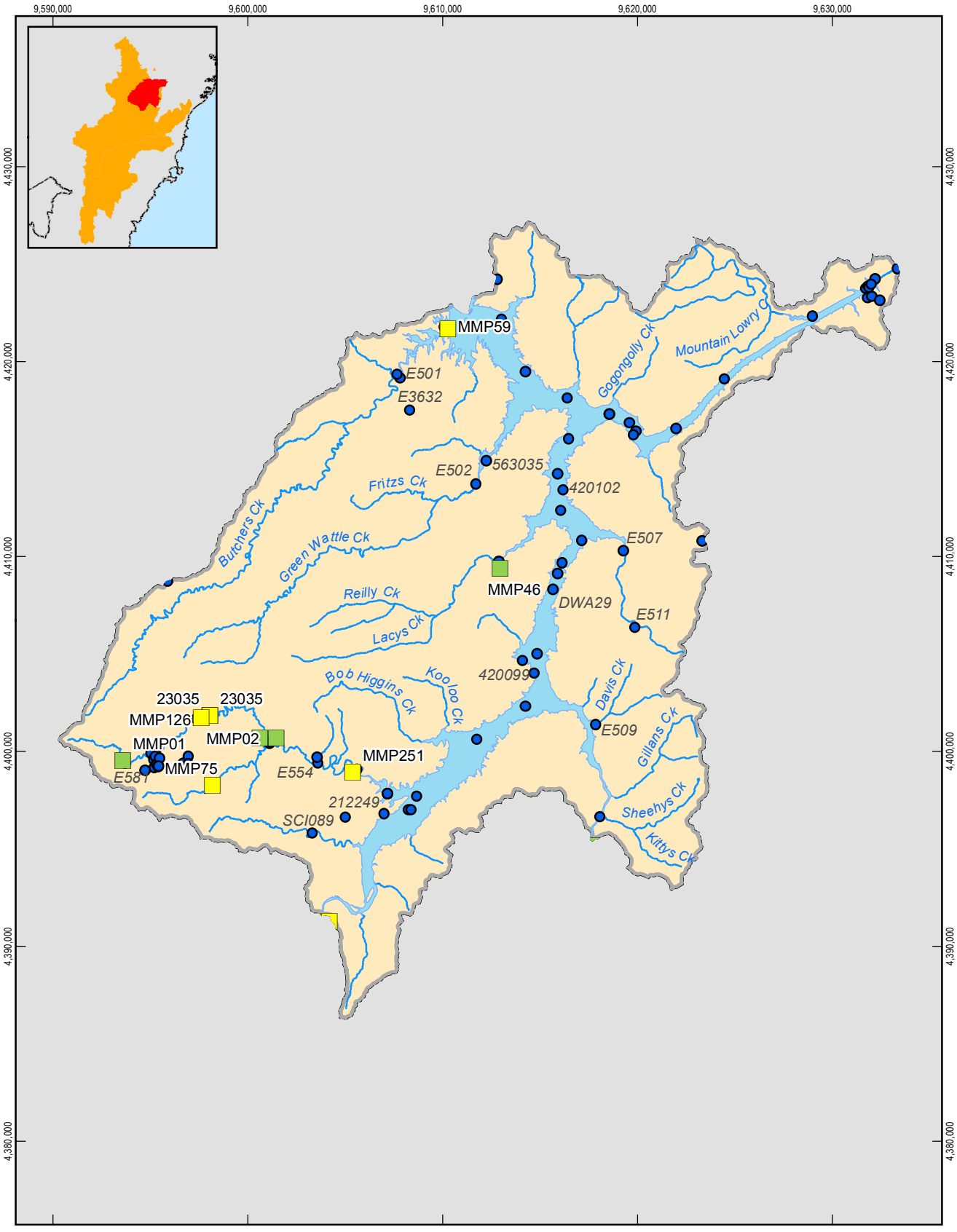


Figure I 1-25 Comparison of AUSRIVAS results from the Lake Burragorang sub-catchment: 2007-09 to 2010-12



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model

Water Quality Monitoring Site

Waterbody

Waterway

Sub-catchment Boundary

Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

N

Sydney Catchment Authority
Catchment Audit 2013

Lake Burragorang Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number	2314960
Revision	0
Date	26 Nov 2013

Figure I1-26

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Level 6, 20 Smith Street Parramatta NSW 2150 Australia T 61 2 8898 8800 F 61 2 8898 8810 E ptamail@ghd.com W www.ghd.com

Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

Table I 1-13 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Lake Burragorang sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
23035	Edge	-34.09407	150.23298							A						
23035	Edge	-34.09407	150.23298							B						
MMP01	Edge	-34.11614	150.18527	fires	dry	dry	dry	B	dry	dry	A	dry			A	
MMP02	Edge	-34.10353	150.26675	fires	B	B	B	A	dry	dry	A	dry			A	
MMP02	Riffle	-34.10353	150.26675					B	dry	dry		dry			A	
MMP126	Edge	-34.09533	150.22831							B						
MMP251	Edge	-34.1182	150.31341								B					B
MMP46	Edge	-34.021944	150.391666												A	
MMP47	Edge	-34.104722	150.35													
MMP59	Edge	-33.911663	150.358336		dry				dry					B	A	B
MMP75	Edge	-34.12615	150.2355			dry		B								

Water availability

Surface water flow

Flow data from one gauge within the Lake Burragorang sub-catchment was considered under this current audit. The assessment of this gauge is consistent with previous audits Table I 1-14 identifies the gauge assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-14 Flow (ML/day) at gauging stations in the Lake Burragorang sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
2122996	Tonalli River at Fire Road W2 (site no. 2)	01/07/2003	4.21	11.69	7.99	4.15	2.24

Flows for the major river inflows to Lake Burragorang are measured in the:

- Coxs River at Kelpie Point (see Mid Coxs River sub-catchment);
- Wollondilly River at Jooriland (see Wollondilly River sub-catchment);
- Nattai River at The Causeway (see Nattai River sub-catchment); and
- Werriberri Creek at Werombi (see Werriberri Creek sub-catchment).

During the audit period, all of these flow gauges recorded median and yearly average flows above the long-term median and average (see individual sub-catchment reports for details). The majority of other minor streams and creeks flowing into Lake Burragorang are not gauged.

Within the Lake Burragorang sub-catchment, flow data during the audit period was available for the Tonalli River at Fire Road W2 (Site #2). This gauge only dates back to 2003 and the flow records contains many long periods of no data (whether due to zero flow in the creek or other reasons) - this gauge is therefore not considered appropriate for comparison or benchmarking against long-term average flows or flows during previous audit periods.

Environmental flows

Warragamba Dam sits within the Lake Burragorang sub-catchment and the flows released from the dam discharge to the Nepean River via the Warragamba River north west of Nortons Basin Road.

Total environmental flows from the dam for the audit period were 34,951 ML. This flow volume is consistent with previous audit periods where 43,452 ML was discharged in the 2007-10 audit period and 31,685 ML in the 2004-07 audit period.

The average environmental flow volume for this audit period is 32 ML/d and this is consistent with the long term (2004 – 2013) average of 33 ML/d. This consistency equates to a relatively static long-term trend i.e. no significant reduction on increase in environmental flows from the dam over the long term period assessed. Table I 1-15 provides a summary of the above data.

Table I 1-15 Summary of environmental flows for the Lake Burragorang sub-catchment

Structure	Total Flow (ML)			Median Flow (ML/day)				Average Flow (ML/day)			
	Current Audit Period	07-10 Audit Period	04-07 Audit Period	Current Audit Period	07-10 Audit Period	04-07 Audit Period	Long Term 2004-2013	Current Audit Period	07-10 Audit Period	04-07 Audit Period	Long Term 2004-2013
Warragamba Dam	34,951	43,452	31,685	30	43	22	30	32	40	29	33

Bulk water transfers

Bulk water transfers are made into and out of the Lake Burragorang sub-catchment. The transfers in are from the Wingecarribee Reservoir via the Wingecarribee and Wollondilly Rivers. Transfers out of Lake Burragorang are directly related to the transfer of water supply from Warragamba Dam from use in urbanised areas around the greater Sydney region.

Table I 1-16 provides a summary of the transfers and volume of flow for the current audit. Table I 1-16 and Figure I 1-27 also provide data from the previous audit periods to provide a long term view of the transfer volumes.

Table I 1-16 Bulk water transfers for the Lake Burragorang sub-catchment

From Reservoir (Sub-catchment)	To Reservoir (Sub-catchment)	Total Volume Transferred (ML)			Median Volume Transferred (ML/day)				Average Volume Transferred (ML/day)			
		2010-13 Audit Period	2007-2010 Audit Period	2004-2007 Audit Period	2010-13 Audit Period	2007-2010 Audit Period	2004-2007 Audit Period	Long Term 2004-2013	2010-13 Audit Period	2007-2010 Audit Period	2004-2007 Audit Period	Long Term 2004-2013
Lake Burragorang [1]	Prospect Reservoir	840,930	874,079	994,033	774	770	895	806	767	798	908	824
Lake Burragorang [2]	Prospect Reservoir	4,959	0	0	0	0	0	0	5	0	0	2
Lake Burragorang [3]	Prospect Reservoir	203,908	284,418	250,215	162	298	250	214	186	260	229	225
Lake Burragorang [4]	Prospect Reservoir	17,372	21,571	16,515	0	0	0	0	16	20	15	17
Lake Burragorang [5]	Prospect Reservoir	186,536	262,847	233,700	159	285	238	203	170	240	213	208
Lake Burragorang [6]	Prospect Reservoir	31,195	14,472	0	0	0	N/A	0	28	13	N/A	21
Wingecarribee River [7]	Lake Burragorang	37,520	202,347	242,443	0	65	200	50	34	185	221	147

Notes:

1. Warragamba Pipelines Cross Conn 3 to Supply;
2. Warragamba Pipelines Cross Conn 3 Diversion to Prospect Reservoir;
3. Upper Canal at HPR1;
4. Upper Canal Diversion to Prospect Res;
5. Upper Canal to Supply;
6. SCA Pumping from Prospect to Supply
7. The flows from the Wingecarribee Reservoir to the Warragamba Dam are via the Wingecarribee River. Further discussion on the flows within this river can be seen in Section 1.15 on flows within the Wingecarribee River sub-catchment.

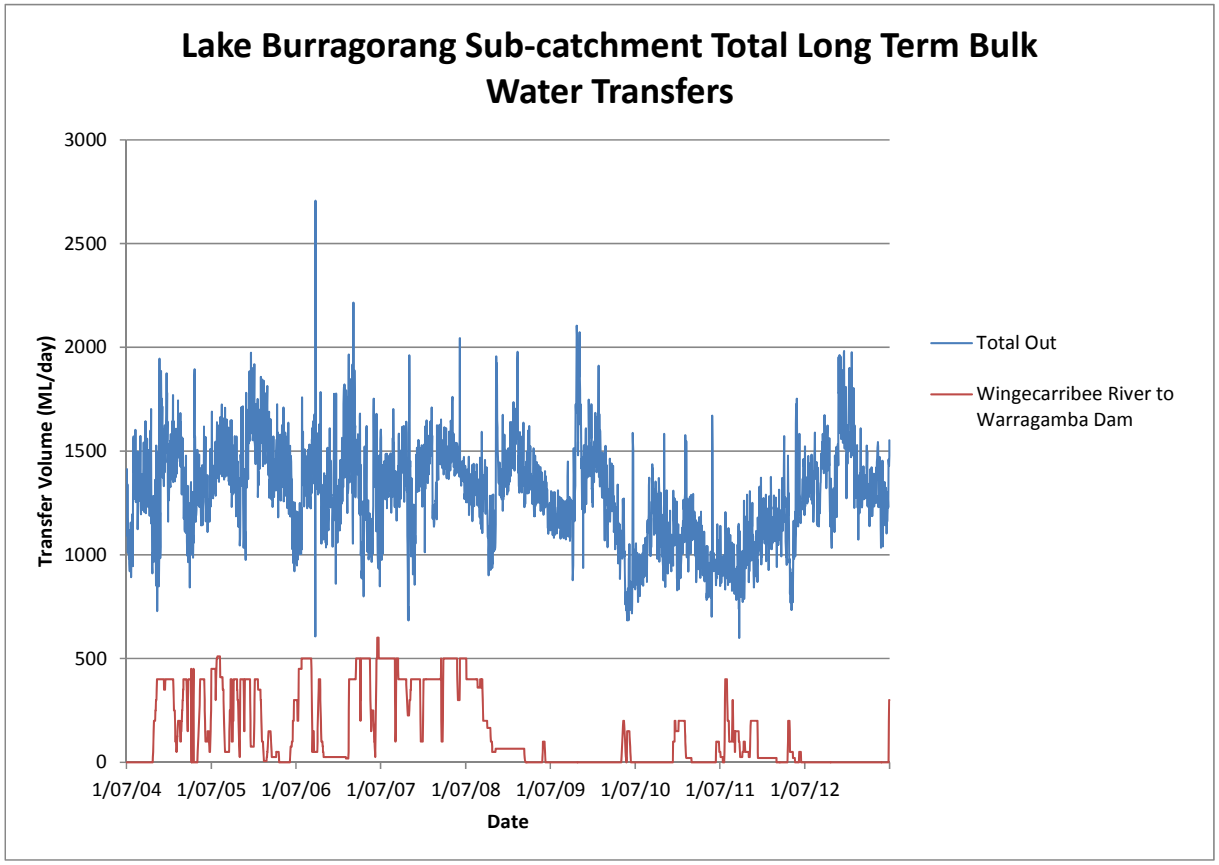


Figure I 1-27 Lake Burragorang sub-catchment total long term bulk water transfers

It can be seen from the data provided in the table that the total volume of water transferred into the sub-catchment during the current audit period is 37,520 ML and the total volume transferred out is 1,284,899 ML.

It can also be seen from Table I 1-16 and Figure I 1-27 that there is a decline in the total volume of water transferred both in and out of the sub-catchment across the period of the three audits.

Catchment water quality

Long-term water quality monitoring in the Lake Burragorang sub-catchment is undertaken by the SCA at E550 (Tonalli River at fire Road W1B), E551 (Tonalli River at Fire Road W2), and E552 (Tonalli River at Cemetery). However, water quality conditions for E551, E550 and E552 were not included in previous audits and no comparisons to previous audits have been made.

E550- Tonalli River at fire Road W1B

- For E550 the median TN concentration for the current audit was 0.270 mg/L: 52% of recordings exceeded the ANZECC guideline for upland rivers. No significant long-term trend was detected for TN.
- For E550 the median TP concentration was 0.015 mg/L during the current audit; 33% of recordings exceeding the ANZECC guideline for upland rivers. No significant long-term trend was detected for TP.
- During the current audit at E550 the median conductivity was 0.110 mS/cm; 2% of recordings exceeding the ANZECC guideline for upland rivers. A significant long-term trend was detected with conductivity decreasing by 0.007 mS/cm per year.

- No chlorophyll à data was available for E550 during the current audit.

E551- Tonalli River at Fire Road W2

- The median TN concentration at E551 during the current audit was 0.330 mg/L; 55% of recordings exceeded the ANZECC guideline for upland rivers. No significant long-term trend was detected for TN.
- The median TP concentration at E551 during the current audit was 0.010 mg/L; 23% of recordings exceeding the ANZECC guideline for upland rivers. A significant long-term trend was detected for TP with concentrations increasing of 0.001 mg/L per year.
- The median electrical conductivity at E551 during the current audit was 0.240 mS/cm; 23% of recordings exceeding the ANZECC guideline for upland rivers. A significant long-term trend was detected with conductivity decreasing by 0.007 mS/cm per year.
- The median chlorophyll à concentration at E551 during the current audit was 0.600 µg/L; 12% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. A significant long-term trend was detected with chlorophyll à decreasing by 0.13 µg/L per year.

E552 - Tonalli River at Cemetery

- The median TN concentration at E552 during the current audit was 0.270 mg/L; 52% of recordings exceeded the ANZECC guideline for upland rivers. A significant long-term trend was detected for TN with concentrations decreasing by 0.006 mg/L per year.
- The median TP concentration at E552 during the current audit was 0.015 mg/L; 33% of recordings exceeding the ANZECC guideline for upland rivers. No significant long-term trend was detected for TP.
- The median electrical conductivity at E552 during the current audit was 0.110 mS/cm; 2% of recordings exceeding the ANZECC guideline for upland rivers. No significant long-term trend was detected for conductivity.
- No chlorophyll à data was available for E552 during the current audit.

Storage water quality

Long-term water quality monitoring in the Lake Burragorang River sub-catchment is undertaken by the SCA at a number of storage monitoring sites; DWA2, DWA9, DWA12, DWA27, DWA39 and DWA311. No water quality data for DWA311 were presented in previous audits so no comparisons have been made.

DWA2 - Lake Burragorang @ 500 m u/s Dam Wall

- The median TN concentration for DWA2 was 0.380 mg/L during the current audit; 68% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was higher than values recorded in previous audits (median values for previous five audits ranged from 0.230 to 0.300 mg/L) and a significant long-term trend was detected with concentrations increasing by 0.002 mg/L per year.
- The median TP concentration for DWA2 was 0.007 mg/L during the current audit; 36% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was greater than values recorded in previous audits (median values for previous five audits ranged from 0.004 to 0.006 mg/L).

A significant long-term trend was detected although this was only minor with concentrations increasing by <0.001 mg/L per year.

- The median electrical conductivity for DWA2 was 0.163 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.164 to 0.196 mS/cm). A significant long-term trend was detected although this was only minor with conductivity decreasing by only 0.001 mS/cm per year.
- The median chlorophyll à concentration for DWA2 was 2.5 µg/L during the current audit; 15% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 2.4 to 5.2 µg/L). A significant long-term trend was detected with chlorophyll à increasing by 0.07 µg/L per year.

DWA9 - Lake Burragorang @ 14 km u/s Dam Wall

- For DWA9 the median TN concentration was 0.420 mg/L during the current audit; 72% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was greater than previous audits (median values for previous five audits ranged from 0.230 to 0.300 mg/L) and a significant long-term trend was detected with concentrations increasing by 0.087 mg/L per year.
- For DWA9 the median TP concentration was 0.009 mg/L during the current audit; 44% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was greater than the range of values recorded in previous audits (median values for previous five audits ranged from 0.004 to 0.006 mg/L). A significant long-term trend was detected with concentrations increasing by 0.002 mg/L per year.
- For DWA9 the median electrical conductivity was 0.164 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.162 to 0.191 mS/cm). A significant long-term trend was detected with conductivity increasing by 0.006 mS/cm per year.
- For DWA9 the median chlorophyll à concentration was 2.6 µg/L during the current audit; 6% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values from previous audits (median values for previous five audits ranged from 2.2 to 4.0 µg/L) and no significant long-term trend was detected.

DWA12 - Lake Burragorang @ 9 km u/s Coxs River

- The median TN concentration for DWA12 was 0.330 mg/L during the current audit; 62% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was again greater than previous audits (median values for previous five audits ranged from 0.240 to 0.300 mg/L) and a significant long-term trend was detected with concentrations increasing by 0.094 mg/L per year.

- The median TP concentration for DWA12 was 0.010 mg/L during the current audit; 45% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was slightly greater than previous audits (median values for previous five audits ranged from 0.005 to 0.006 mg/L) and a significant long-term trend was detected with concentrations increasing by 0.005 mg/L per year.
- The median electrical conductivity for DWA12 was 0.161 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was again within the range of values recorded in previous audits (median values for previous five audits ranged from 0.156 to 0.189 mS/cm). A significant long-term trend was detected with conductivity increasing by 0.008 mS/cm per year.
- The median chlorophyll à concentration for DWA12 was 2.9 µg/L during the current audit; 8% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was again within the range of values from previous audits (median values for previous five audits ranged from 2.3 to 3.9 µg/L). No significant long-term trend was detected for chlorophyll à at DWA12.

DWA27 - Lake Burragorang @ Wollondilly Arm 23 km u/s Dam

- For DWA27 the median TN concentration was 0.440 mg/L during the current audit; 76% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was greater than previous audits (median values for previous five audits ranged from 0.240 to 0.310 mg/L). A significant long-term trend was detected with concentrations increasing by 0.094 mg/L per year.
- For DWA27 the median TP concentration was 0.010 mg/L during the current audit; 47% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was greater than values recorded in previous audits (median values for previous five audits ranged from 0.005 to 0.006 mg/L). A significant long-term trend was detected with concentrations increasing by 0.004 mg/L per year.
- For DWA27 the median electrical conductivity was 0.173 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.165 to 0.207 mS/cm). A significant long-term trend was detected with conductivity increasing by 0.006 mS/cm per year.
- For DWA27 the median chlorophyll à concentration was 2.8 µg/L during the current audit; 12% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values from previous audits (median values for previous five audits ranged from 2.1 to 4.1 µg/L) and no significant long-term trend was detected.

DWA39 - Lake Burragorang @ Wollondilly Arm 40 km u/s Dam

- The median TN concentration for DWA39 was 0.580 mg/L during the current audit; 94% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was noticeably greater than previous

audits (median values for previous five audits ranged from 0.290 to 0.340 mg/L). Despite this, no significant long-term trend was detected for TN at DWA39.

- The median TP concentration for DWA39 was 0.018 mg/L during the current audit; 94% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was within the range of values recorded in previous audits (median values for four five audits ranged from 0.010 to 0.025 mg/L). No significant long-term trend was detected for TP at DWA39.
- The median electrical conductivity for DWA39 was 0.194 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.176 to 0.230 mS/cm). No significant long-term trend was detected for conductivity at DWA39.
- The median chlorophyll à concentration for DWA39 was 5.2 µg/L during the current audit; 51% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was higher than for previous audits (median values for previous three audits ranged from 3.8 to 5.0 µg/L) although no significant long-term trend was detected.

DWA311 - Lake Burragorang @ Wollondilly Arm 300 m u/s Nattai River

- During the current audit the median TN concentration at DWA311 was 0.410 mg/L; 67% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. A significant long-term trend was detected with TN concentrations increasing by 0.111 mg/L per year.
- The median TP concentration for DW311 was 0.008 mg/L during the current audit; 39% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. A significant long-term trend was detected for TP with concentrations increasing by 0.004 mg/L per year.
- For DWA311 the median electrical conductivity was 0.179 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. A significant long-term trend was detected with conductivity increasing by 0.004 mS/cm per year.
- For DWA311 the median chlorophyll à concentration was 4.7 µg/L during the current audit; 43% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. No significant long-term trend was detected.

1.8 Werriberri Creek

1.8.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Werriberri Creek sub-catchment are shown Figure I 1-28.

The primary land use in the Werriberri Creek sub-catchment is classed as Conservation and Natural Environments (55.6%) which covers approximately 9147 ha and is chiefly made up of the tertiary class Nature conservation (42.6%) and Other minimal uses (12.9%).Production form Dryland Agriculture (25.4%) is the second most extensive land use in the Werriberri Creek sub-catchment and this principally consists of Grazing modified pastures (25.0%). Intensive Uses (15.0%) also cover a considerable portion of the sub-catchment and this is mostly Residential and farm infrastructure (11.0%).

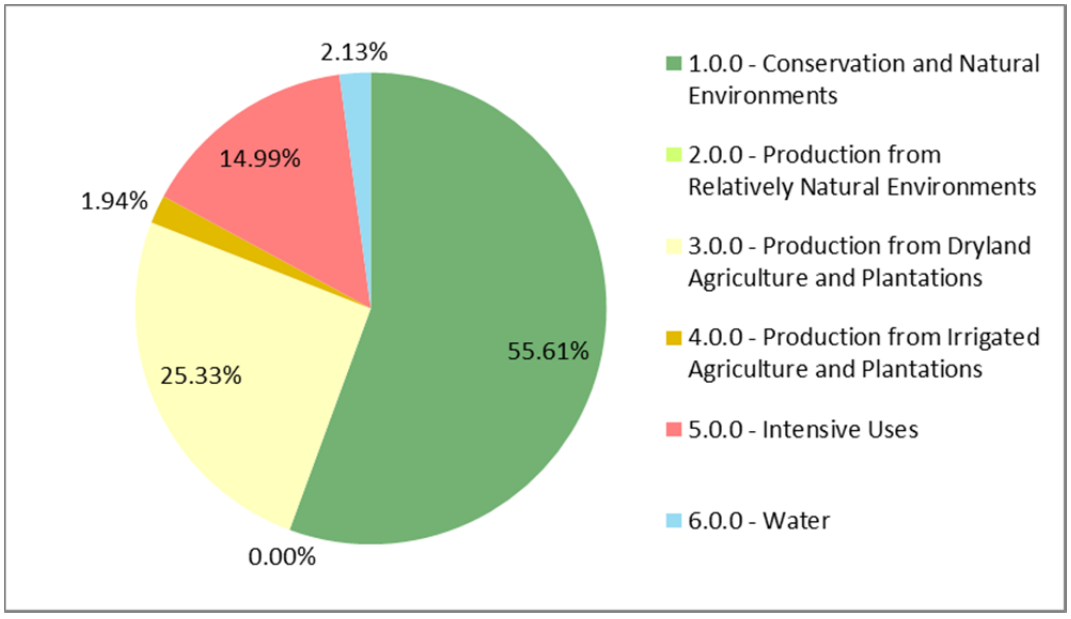


Figure I 1-28 Land use in the Werriberri Creek sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Werriberri Creek sub-catchment were primarily sourced from the SCA macroinvertebrate monitoring program with data for three additional sites provided by OEH. The results are summarised in Figure I 1-29, Figure I 1-30, and Table I 1-17.

A total of 11 sites have been sampled in the Werriberri Creek sub-catchment with a total of 42 samples collected with 40 since spring 2001 and an additional two historic samples. Both historic samples were collected from the same site (1 riffle and 1 edge) and both were assessed as more biologically diverse than reference (band X) however the majority of samples collected since 2001 have been assessed as reference condition (band A) (61.9%), followed by significantly impaired (band B) (26.2%) and severely impaired (band C) (7.1%).

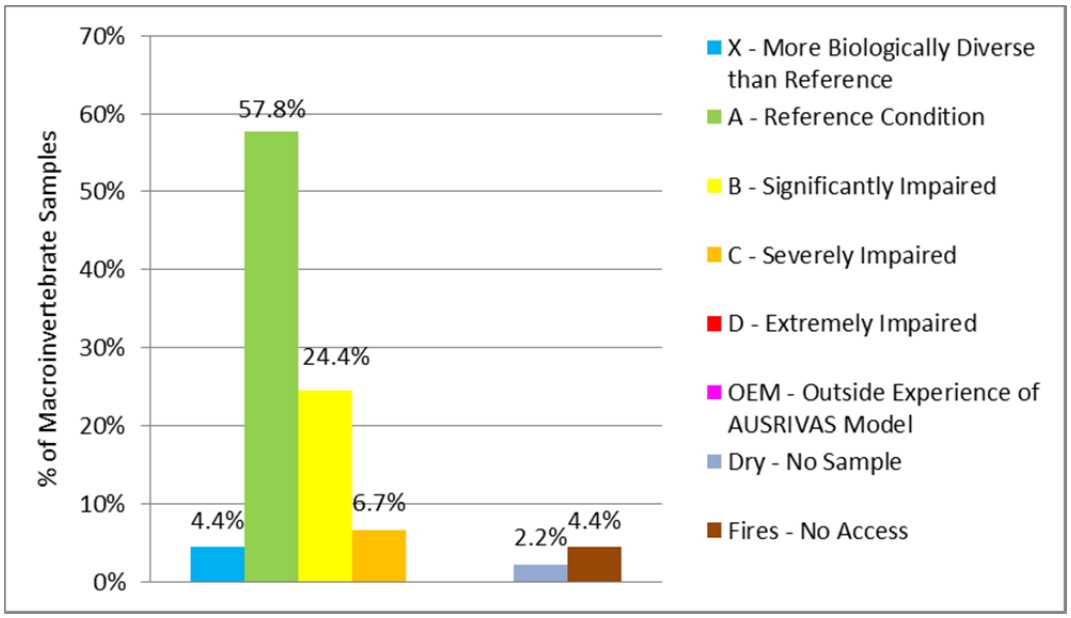


Figure I 1-29 Distribution of AUSRIVAS results for macroinvertebrate all sample data provided for the Werriberri Creek sub-catchment

Two sites were consistently sampled between 2001 and 2011 (MMP03 and MMP57) and the majority of these samples were rated as reference condition (band A). MMP03 was the more consistent of the two sites and consistently maintained both edge and rifle habitats while MMP57 recorded data for edge habitat only and AUSRIVAS results for this site fluctuated. Both these sites were rated as significantly impaired (band B) in 2010 but improved in 2011 to reference condition (band A).

E531 was sampled for the first time in spring 2012 and was the only site sampled in the Werriberri Creek sub-catchment in 2012. Two edge habitat samples were collected both of which received an AUSRIVAS assessment of reference condition (band A).

Analysis of the AUSRIVAS data presented in the previous audit compared to data provided for the 2010 to 2012 period (Figure I 1-30) shows a slight decline in AUSRIVAS health ratings across the Werriberri Creek sub-catchment. A reduction in sites assessed as reference condition (band A) and increase in sites assessed as severely impaired was the key reason for this; however, the majority of sites sampled during this audit period were assessed as reference condition.

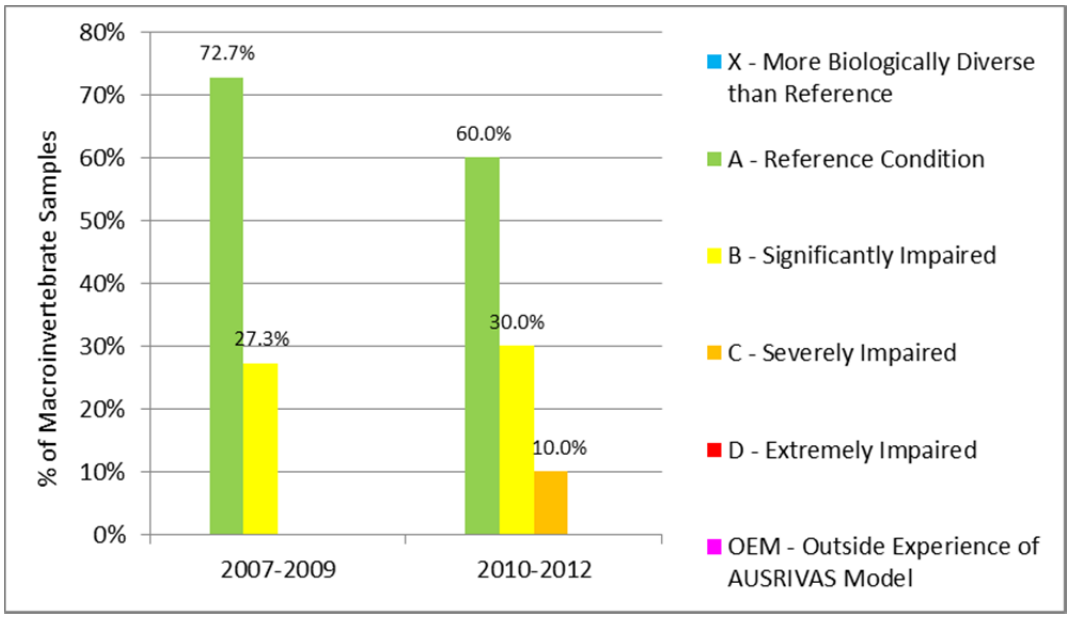
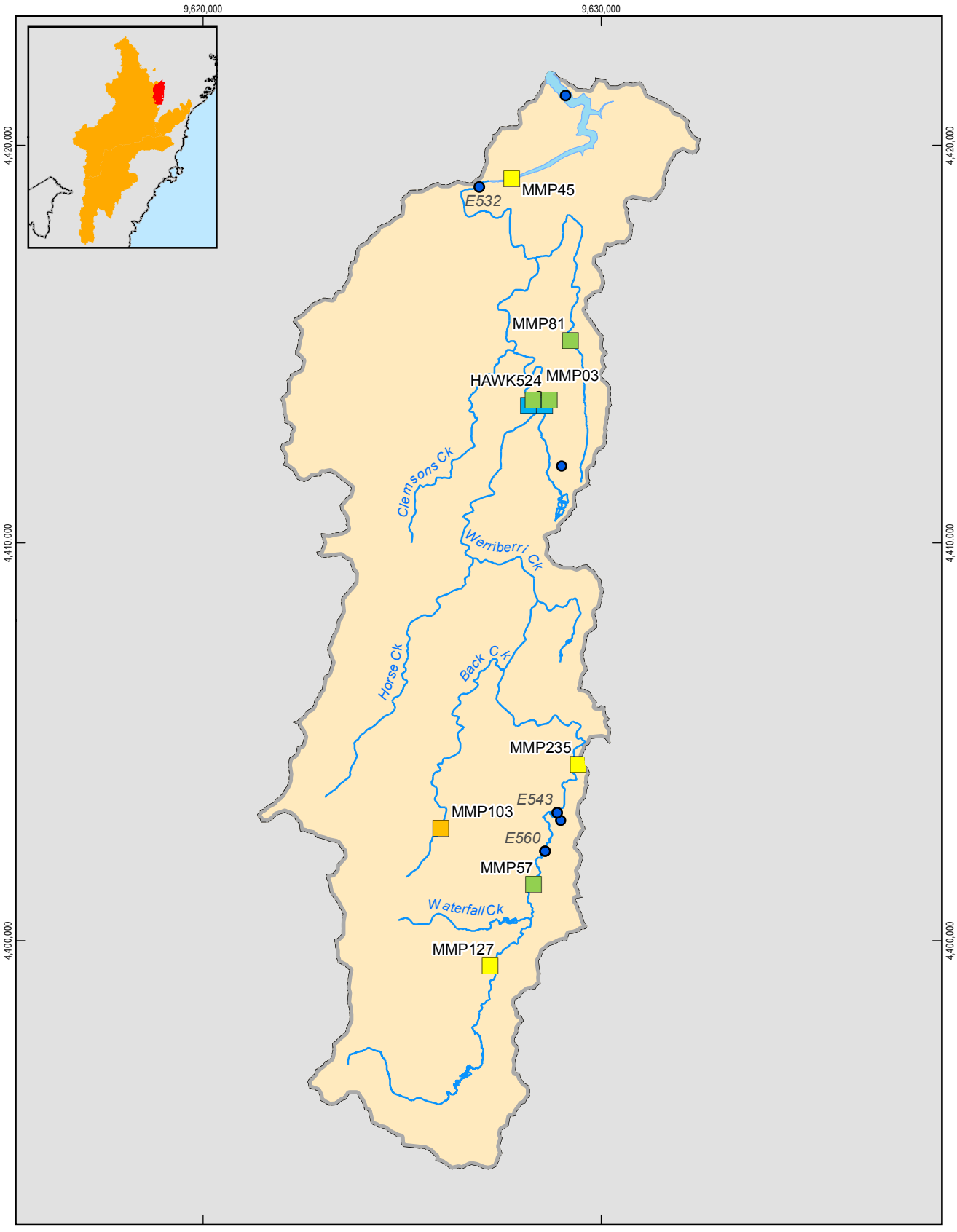


Figure I 1-30 Comparison of AUSRIVAS results from the Werriberri Creek sub-catchment: 2007-09 to 2010-12



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model

Water Quality Monitoring Site

Waterbody

Waterway

Sub-catchment Boundary

Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
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Sydney Catchment Authority
Catchment Audit 2013

Werri Berri Creek Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number 2314960
Revision 0
Date 26 Nov 2013

Figure I 1-31

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Table I 1-17 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Werriberri Creek sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
HAWK524	Edge	-33.9805	150.5579	X												
HAWK524	Riffle	-33.9805	150.5579	X												
MMP03	Edge	-33.97936	150.55922		fires	A	A	B	A	A	A	A	A	B	A	
MMP03	Riffle	-33.97936	150.55922		fires		A	A	A	B	A	A	A	B	A	
MMP103	Edge	-34.07705	150.53537					A		C						
MMP127	Edge	-34.10793	150.55009						B							
MMP235	Edge	-34.06155	150.57224									B				
MMP45	Edge	-33.9294	150.54865			B										
MMP57	Edge	-34.08907	150.56116		A	A	A	C	B	A	A	B	B	B	A	
MMP81	Edge	-33.96555	150.56615				dry				A					
23187	Edge	-34.06211	150.57203												C	
23198	Edge	-34.10275	150.55698												A	
E531	Edge	-34.0891	150.5612													A
E531	Edge	-34.0891	150.5612													A

Water availability

Surface water flow

Flow data from one gauge within the Werriberri Creek sub-catchment was considered under this current audit. The assessment of this gauge is consistent with previous audits. Table I 1-18 identifies the gauge assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-18 Flow (ML/day) at gauging stations in the Werriberri Creek sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
212244	Werriberri Creek at Werombi	01/06/1988	2.87	1.21	2.40	1.38	3.12
568051	Oakdale Rain Gauge	05/06/1981	0 Mean = 2.16	0 Mean = 1.69	0 Mean = 2.49	0 Mean = 2.42	0 Mean = 2.13

Flow records for the Werriberri Creek at Werombi showed a similar number of zero flow days to the previous audit (35%), which is significantly more than in both the 2001-2007 period (18%) and the long-term average (14%). When the gauge did record flows, those flows were typically higher than the previous audit period and the long-term average. The median flow for the gauge during the audit period was 3.1 ML/day, with a long-term median of 2.9 ML/day. The 10% exceedance flow during the audit period was 41.4 ML/day, against a long-term average 90% exceedance flow of 28.7 ML/day.

Catchment water quality

Long-term water quality monitoring in the Werriberri Creek sub-catchment is undertaken by the SCA at Werombi (Site E531 – downstream of the Werombi township approximately 10 km upstream of Lake Burragorang).

- The median TN concentration for E531 was 0.250 mg/L during the current audit; 49% of recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was lower than for all previous audits (median values for previous five audits ranged from 0.330 to 0.870 mg/L). No significant long-term trend was detected for TN.
- During the current audit the median TP concentration for E531 was 0.012 mg/L; 22% of recordings above the ANZECC guideline for upland rivers. The median TP concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.010 to 0.19 mg/L). A significant long-term trend was detected for TP although this was only minor with concentrations increasing by <0.001 mg/L per year.
- The median electrical conductivity for E531 was 0.389 mS/cm during the current audit; 81% of recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was greater than all other audits (median values for

previous five audits ranged from 0.277 to 0.320 mS/cm). Despite this, no significant long-term trend was detected for conductivity at E531.

- The median chlorophyll à concentration for E531 was 1.9 µg/L during the current audit; 8% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was generally similar to other audits (median values for previous five audits ranged from 0.9 to 2.7 µg/L). A significant long-term trend was detected with concentrations increasing by 0.08 µg/L per year.

Storage water quality

Not available.

1.9 Little River

1.9.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Little River sub-catchment are shown Figure I 1-32.

The vast majority of land use in the Little River sub-catchment is Conservation and Natural Environments (94.4%) and this covers approximately 17,340 ha and is chiefly comprised of the tertiary classes Nature conservation (77.1%) and Managed resource protection (14.5%). Intensive Uses (3.8%) is second most extensive land use class cover and this primarily consists of the Residential and farm infrastructure (3.1%). Grazing modified pastures (1.5%) also covers a small portions of the Little River sub-catchment.

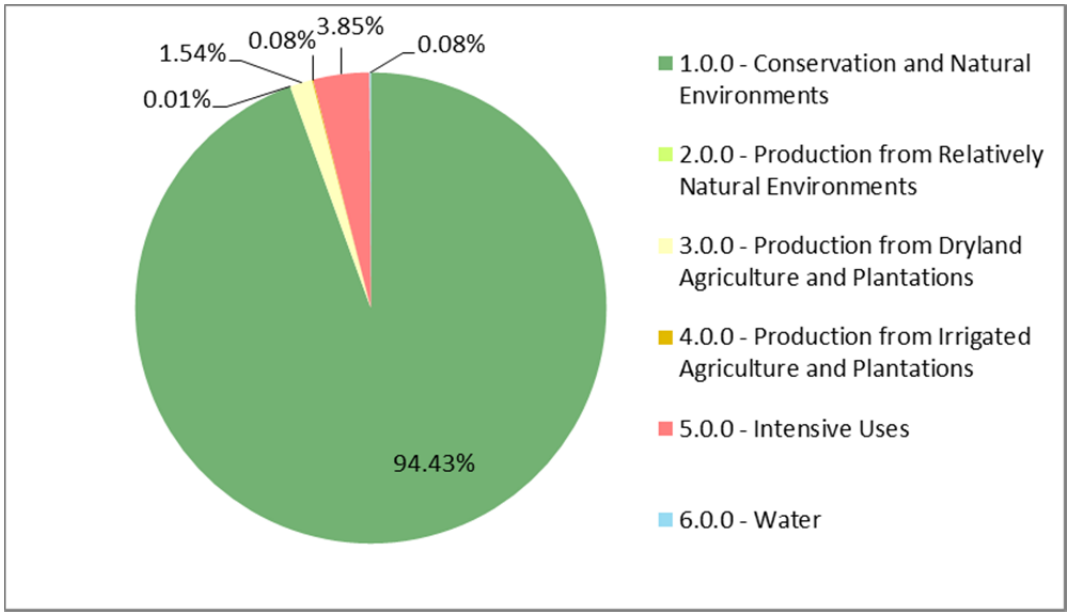


Figure I 1-32 Land use in the Little River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Little River sub-catchment were primarily sourced from the SCA macroinvertebrate monitoring program with data for two additional sites provided by OEH. The results are summarised in Figure I 1-33 and Table I 1-19.

Nine sites in the Little River sub-catchment have been sampled for macroinvertebrates including all SCA and OEH monitoring programs with riffle occurring at three sites. A total of 37 samples have been collected including 33 samples from 20010 to 2012 and four historic samples. Two sites were unable to be sampled in 2001 due to fires in the sub-catchment and one site was dry in 2009.

Approximately 43.2% of samples received an AUSRIVAS assessment of significantly impaired (band B) closely followed by reference condition (band A) (40.5%), more biologically diverse than reference condition (8.1%) and severely impaired (5.4%).

Two sites (MMP04 and MMP05) have been sampled relatively consistently since 2002 and AUSRIVAS assessment for both sites has fluctuated over time. MMP04 has only maintained edge habitat and results have generally shown the site to be significantly impaired (band B)

however the most recent samples for this site have shown dramatic improvement since it was rated as Outside the Model Experience in 2008, dry in 2009, then consistently moved up the bands from severely impaired (band C) in 2010 to reference condition (band A) in spring 2012.

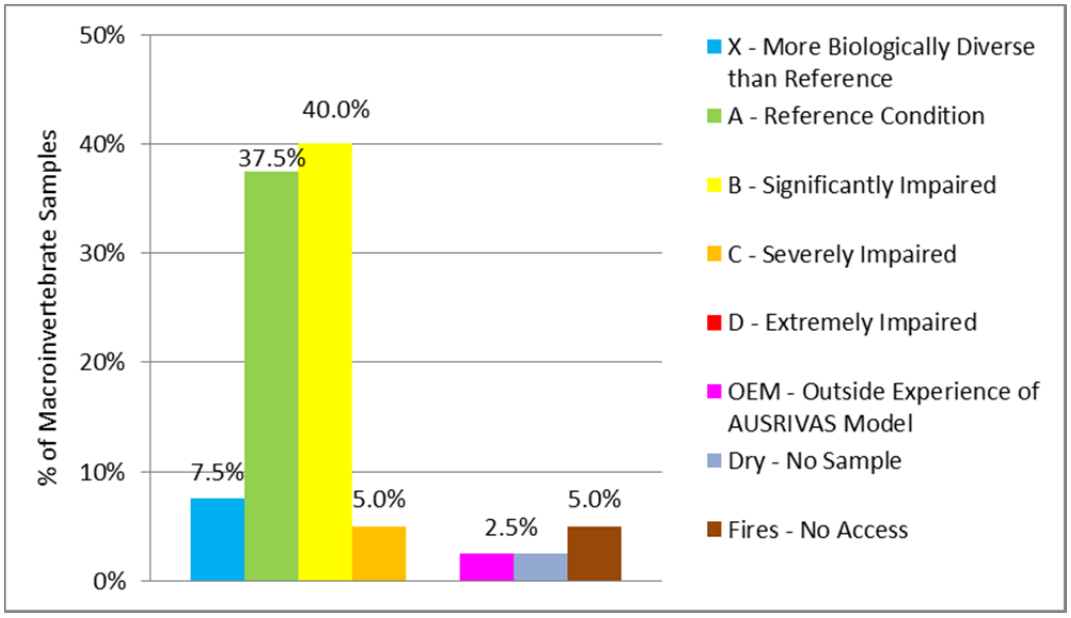


Figure I 1-33 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Little River sub-catchment

Both the edge and riffle habitat samples at MMP05 also showed improvement in condition during this audit period moving from significantly impaired (band B) in spring 2010 to more biologically diverse than reference in spring 2011. Unfortunately this site was not sampled in 2012.

Comparison of results from the previous audit period to the AUSRIVAS data provided for the current audit period (Figure I 1-33) have shown the Little River sub-catchment to change but overall assessment remains relatively consistent. Changes in condition assessments were an increase in sites assessed as more biologically diverse than reference, a decrease in sites ranked reference condition and an increase in sites assessed as significantly impaired and severely impaired.

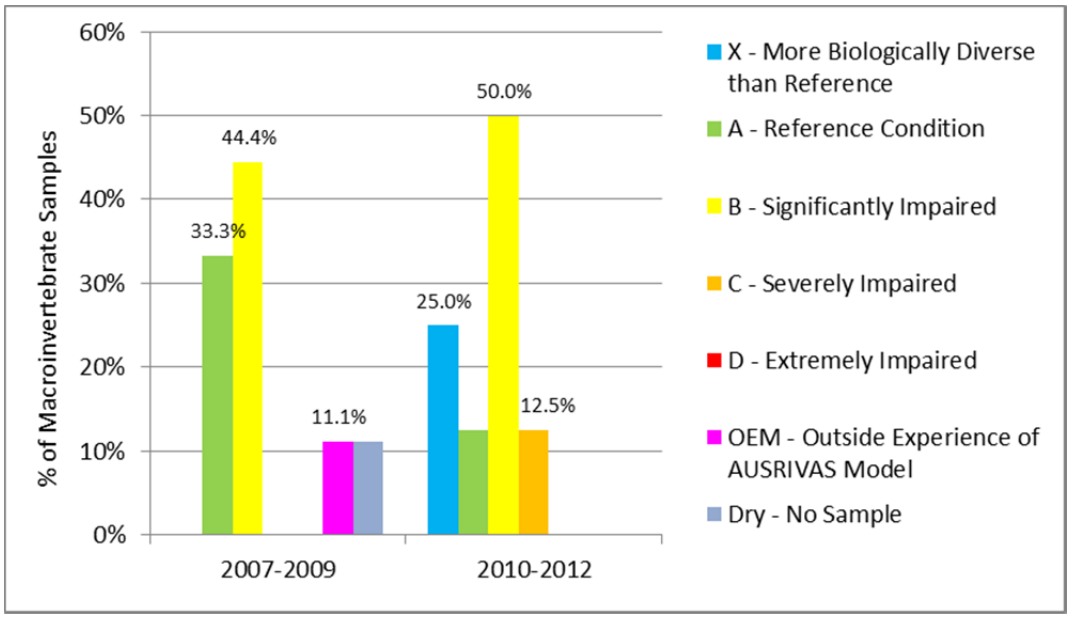
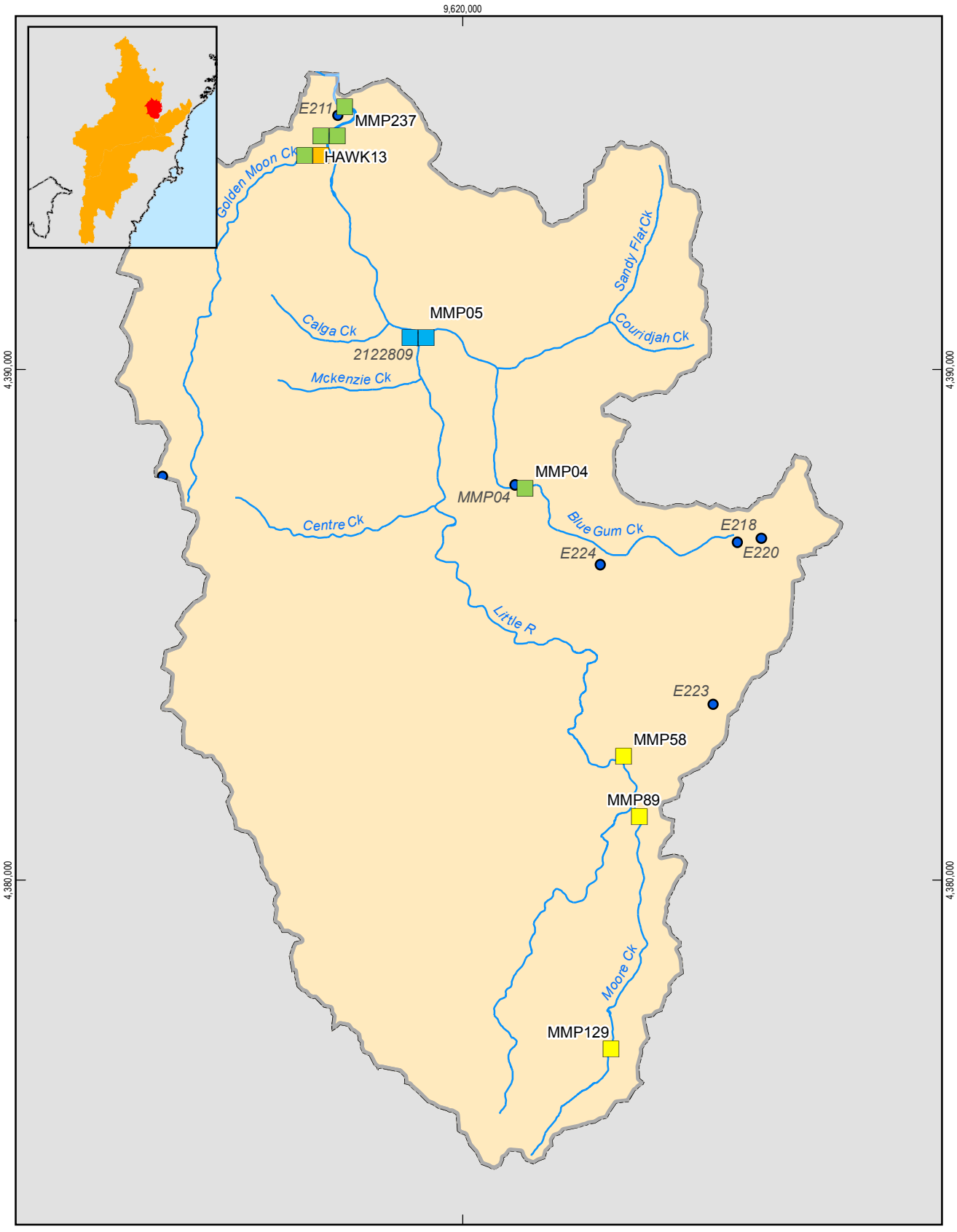


Figure I 1-34 Comparison of AUSRIVAS results from the Little River sub-catchment: 2007-09 to 2010-12



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model
- *Water Quality Monitoring Site*
- Waterbody
- Waterway
- Sub-catchment Boundary
- Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Sydney Catchment Authority
Catchment Audit 2013

Little River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number	2314960
Revision	0
Date	26 Nov 2013

Figure I 1-35

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Table I 1-19 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Little River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
E243	Edge	-34.2152	150.4894													B
HAWK118	Edge	-34.1541	150.4456	A												
HAWK118	Riffle	-34.1541	150.4456	A												
HAWK13	Edge	-34.1576	150.4422	A												
HAWK13	Riffle	-34.1576	150.4422	C												
MMP04	Edge	-34.2152	150.48938		fires	B	A	B	B	B	B	OEM	dry	C	B	A
MMP05	Edge	-34.18919	150.46594		fires	A	A	A	A	A	B	B	A	B	X	
MMP05	Riffle	-34.18919	150.46594				A		X	B	A			B	X	
MMP129	Edge	-34.31378	150.5116						B							
MMP237	Edge	-34.14884	150.44827								A					
MMP58	Edge	-34.26194	150.5122			A	B					B				
MMP89	Edge	-34.27259	150.51606					B								

Water availability

Surface water flow

Flow data from one gauge within the Little River sub-catchment was considered under this current audit. The assessment of this gauge is consistent with previous audits. Table I 1-20 identifies the gauge assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-20 Flow (ML/day) at gauging stations in the Little River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
2122809	Little River at Fire Road W41	21/08/1990	5.52	5.49	5.17	N/A	5.72

The Little River at Fire Road W4I gauge was burnt during the 2001-02 fire and a temporary gauge put in as a replacement. Between June 2007 and May 2012, no flows were recorded. Flow gauging recommenced at the site in May 2012.

As noted in Table I 1-20, no flow records were available in the Little River sub-catchment during the 2007 – 2010 audit period and as a consequence the long term trend median does not take this period into account. The 2007 – 2010 Audit report recommended that the SCA re-instate a permanent flow gauging station in the Little River sub-catchment so that longer-term trends in flow can be assessed in the future. This has been done, however, only one year of data is available during the current audit period. Therefore, this gauge is not considered appropriate for comparison or benchmarking against long-term records at this stage.

Catchment water quality

Long-term water quality monitoring in the Little River sub-catchment is undertaken by the SCA at the Little River (E243 –mid catchment approximately 7 km upstream of the confluence with the Nattai River).

- For E243 the median TN concentration for the current audit was 0.065 mg/L; 3% of recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was less than all previous audits (median values for previous five audits ranged from 0.070 to 0.350 mg/L). A significant long-term trend was detected for TN with concentrations decreasing by 0.011 mg/L per year.
- For E243 the median TP concentration during the current audit was 0.009 mg/L; 6% of recordings exceeded the ANZECC guideline for upland rivers. The median TP concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.004 to 0.012 mg/L). No significant long-term trend was detected for TP at E243.
- For E243 during the current audit the median electrical conductivity was 0.134 mS/cm; no recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.078 to 0.146 mS/cm). A significant long-term trend was detected with conductivity decreasing by 0.001 mS/cm per year.

- During the current audit the median chlorophyll à concentration at E243 was 0.5 µg/L; 3% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values detected in previous audits (median values for previous five audits ranged from 0.1 to 0.7 µg/L). Despite this, a significant trend was detected with chlorophyll à decreasing by 0.02 µg/L per year.

Storage water quality

Thirlmere Lakes are found within the Thirlmere Lakes National Park at the upper end of the Little River sub-catchment. No water quality data were available for Thirlmere Lakes.

1.10 Nattai River

1.10.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Nattai River sub-catchment are shown in Figure I 1-36.

Similar to the majority of sub-catchments in the northern half of the SCA catchment land use in the Nattai River sub-catchment is mainly Conservation and Natural Environments (77.8%) and this is predominantly the tertiary classes of Nature conservation (54.3%) and Other minimal use (15.8%). The second most extensive cover class is Production from Dryland Agriculture and Plantations (12.5%) and this is chiefly comprised of Grazing modified pastures (12.3%). The Intensive Uses (5.9%) land use class in the Little River sub-catchment is predominantly attributed to Residential and farm infrastructure (4.3%) and the tertiary class of Production forestry (3.1%) wholly accounts for the Production from Relatively Natural Environments land use class.

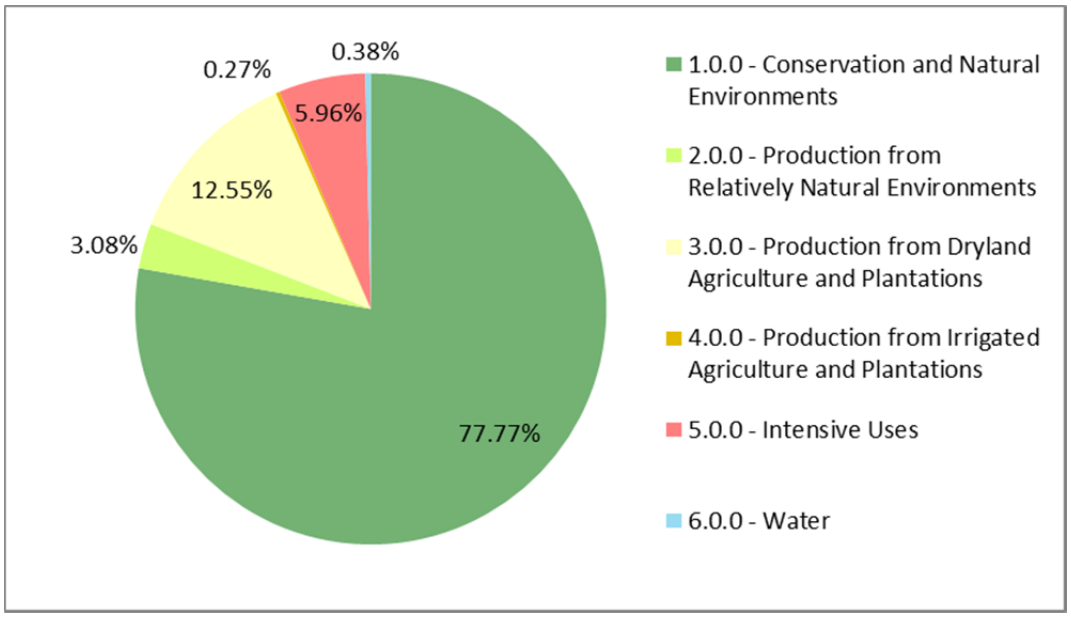


Figure I 1-36 Land use in the Nattai River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Nattai River sub-catchment were primarily sourced from the SCA macroinvertebrate monitoring program with data for five additional sites provided by OEH. The results are summarised in Figure I 1-37, Figure I 1-37, Figure I 1-39, and Table I 1-21.

Eleven sites have been sampled for macroinvertebrates in the Nattai River sub-catchment since 2001 and riffle habitat was present at five of these sites. A total of 57 samples have been collected since 2001 and the majority of these were assessed by AUSRIVAS to be reference condition (band A) (52.6%), followed by significantly impaired (band B) (40.4%) and severely impaired (band C) (5.3%).

Two sites in the Nattai River sub-catchment have been consistently sampled since 2001 (E206 and E210) both of which largely maintained edge and riffle habitats. While both sites were initial

assessed as reference condition (band A) E206 was generally more consistent in this assessment and E210 declined in condition from 2004 to 2010 when both riffle and edge habitats for this site were assessed as severely impaired (band C). Both of these long-term monitoring sites were consecutively sampled during the three years of this audit period and both sites observed an improvement from 2010 to 2011 then a decline in 2012 with all samples in 2012 assessed as significantly impaired (band B).

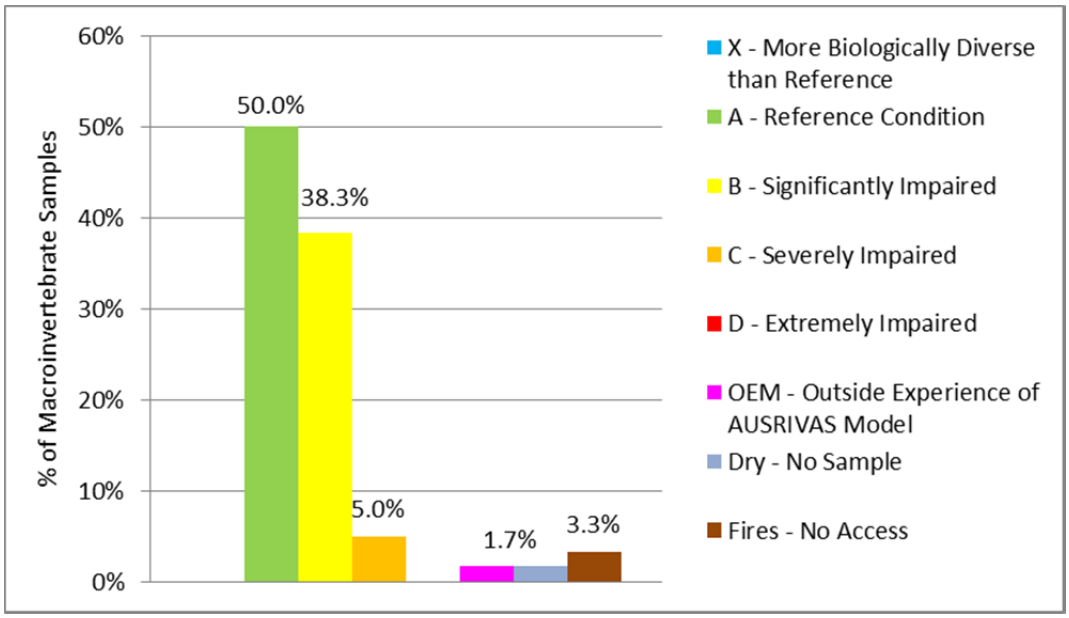


Figure I 1-37 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Nattai River sub-catchment

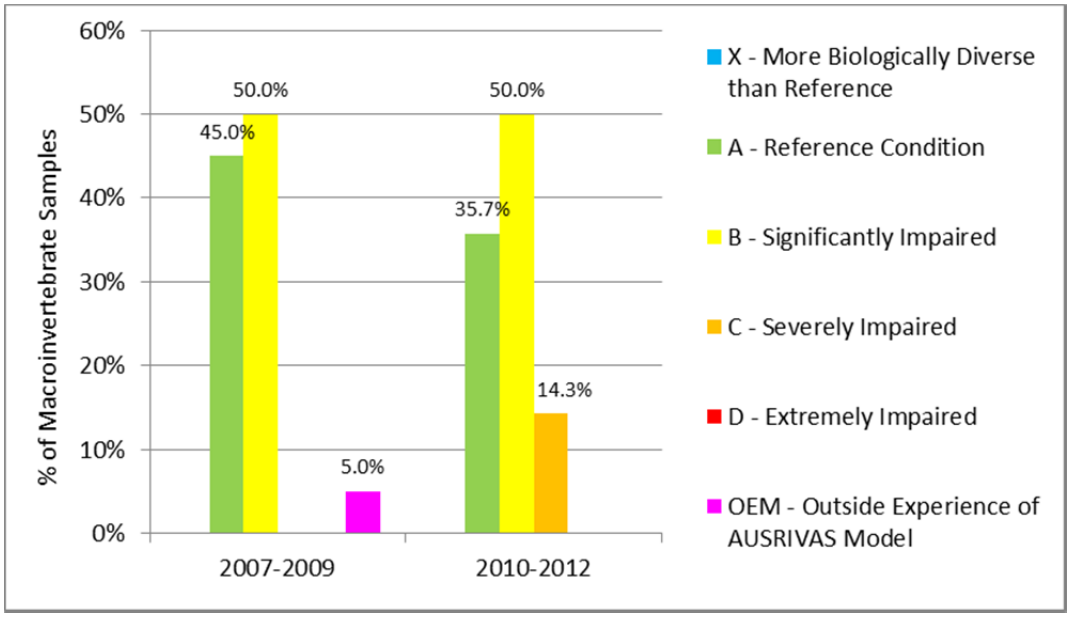
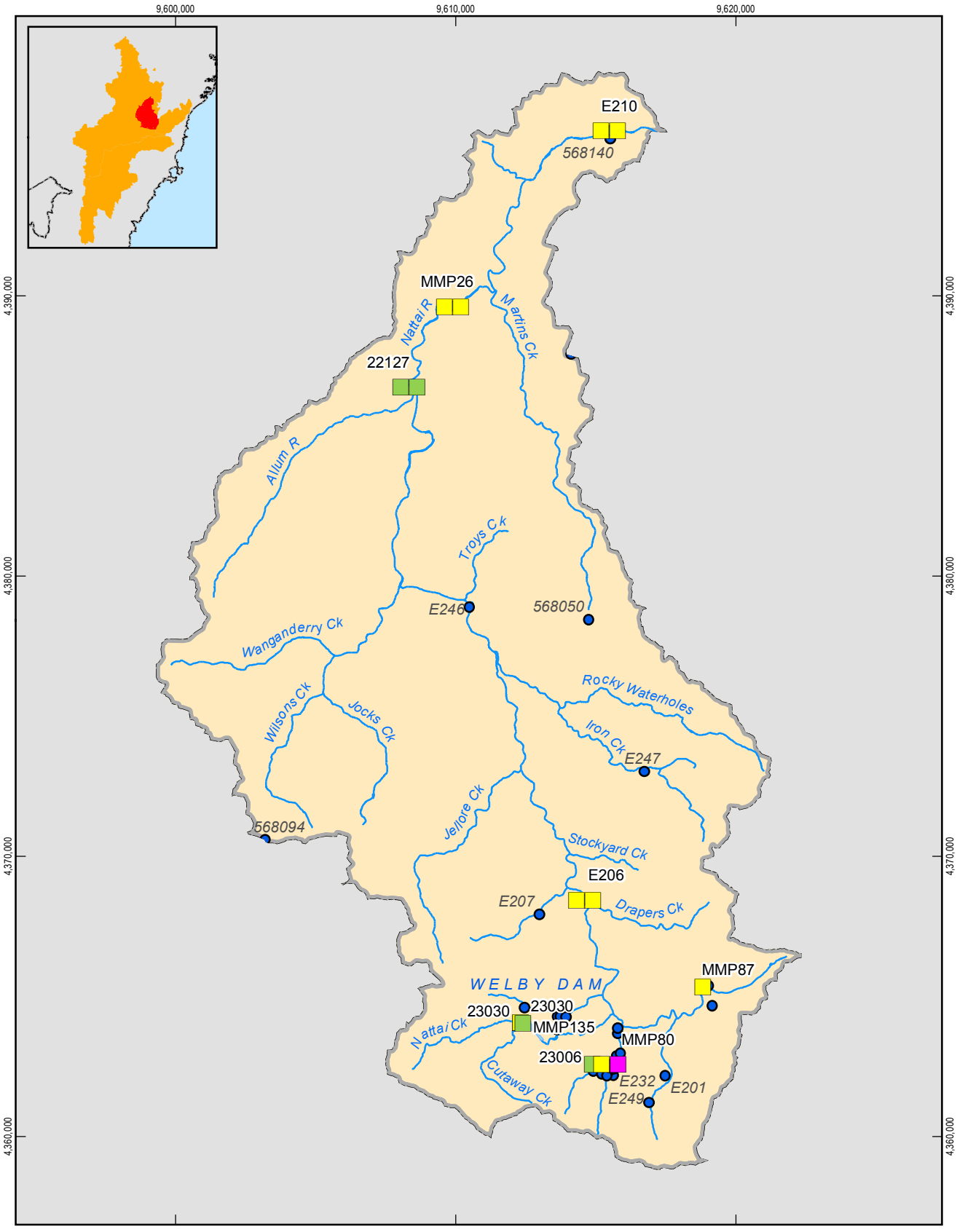


Figure I 1-38 Comparison of AUSRIVAS results from the Nattai River sub-catchment: 2007-09 to 2010-12

A comparison of AUSRIVAS results from the Nattai River sub-catchment for the previous audit period to those provided for the 2010 to 2012 audit period (Figure I 1-38) show only slight changes in condition of sites across the catchment. A slight reduction in sites assessed as reference condition and an increase in sites assessed as severely impaired suggests a slight decline in overall catchment condition since 2009.



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

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Water Quality Monitoring Site

Waterbody

Waterway

Sub-catchment Boundary

Focus Sub-catchment

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Sydney Catchment Authority
Catchment Audit 2013

Nattai River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number	2314960
Revision	0
Date	26 Nov 2013

Figure I 1-39

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Table I 1-21 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Nattai River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
23164	Edge	-34.41719	150.4711												A	
23168	Edge	-34.45045	150.4562												B	
22127	Edge	-34.22752	150.35038										A			
22127	Riffle	-34.22752	150.35038										A			
23006	Edge	-34.44351	150.42938								A					
23030	Edge	-34.4308	150.40102								A					
23030	Edge	-34.4308	150.40102								B					
E206	Edge	-34.39076	150.42502		A	A	A	A	A	A	A	B	A	B	A	B
E206	Riffle	-34.39076	150.42502				A	A	A	A	B	A	A	B	A	B
E210	Edge	-34.14287	150.42482		fires	A	A	A	B	B	B	B	B	C	A	B
E210	Riffle	-34.14287	150.42482		fires		A	B	A	B	A		B	C	A	B
MMP135	Edge	-34.43106	150.40186						A							
MMP26	Edge	-34.20114	150.36633			dry				B	B					
MMP26	Riffle	-34.20114	150.36633								B					
MMP80	Edge	-34.44333	150.43694				C					B				
MMP80	Riffle	-34.44333	150.43694									OEM				
MMP87	Edge	-34.41733	150.47144					B								

Water availability

Surface water flow

Flow data from two gauges within the Nattai River sub-catchment was considered under this current audit. The assessment of these gauges is consistent with previous audits Table I 1-22 identifies the gauges assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-22 Flow (ML/day) at gauging stations in the Nattai River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
212280	Nattai River at The Causeway	07/07/1965	18.58	10.14	6.63	6.50	20.86
2122801	Nattai River at The Crags	12/07/1990	5.43	3.55	3.51	4.20	7.79

Flows in the upstream gauge on Nattai River at The Crags (monitor 2122801) show higher flows than the long-term records and the previous audit periods over the full flow exceedance curve. The audit period median flow was 7.8 ML/day, compared with the long-term median of 5.4 ML/day.

Flows in the downstream gauge on the Nattai River at The Causeway (monitor 212280) also show higher flows during the audit period than the long-term record, although not by as much as the upstream gauge. This is likely due to the longer record available at the Causeway gauge, which contains more years of high flow and therefore shows relatively higher long-term flow averages than the short-record station at The Crags. The audit period median flow at The Causeway was 20.9 ML/day, compared with the long-term median of 18.6 ML/day.

Catchment water quality

Long-term water quality monitoring in the Nattai River sub-catchment is undertaken by the SCA at Gibbergunyah Creek (E203 – immediately downstream of the Braemar Sewage Treatment Plant discharge), the Nattai River at the Crags (E206 – approximately 5 km downstream of the Nattai River and Gibbergunyah Creek confluence), and the Nattai River at Smallwoods Crossing (E210 – located in the lower Nattai approximately 4 km upstream of the Nattai and Little River confluence).

E203 - immediately downstream of the Braemar Sewage Treatment Plant discharge

- For E203 the median TN concentration for the current audit was 1.890 mg/L; all recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was less than the previous three audits that had available data (median values for previous three audits ranged from 2.830 to 4.225 mg/L). A significant long-term trend was detected for TN with concentrations decreasing by 0.298 mg/L per year.

- For E203 the median TP concentration was 0.078 mg/L during the current audit; all recordings exceeding the ANZECC guideline for upland rivers. The median TP concentration during the current audit was less than the previous three audits that had available data (median values ranged from 0.090 to 0.100 mg/L). A significant long-term trend was detected for TP with concentrations decreasing by 0.003 mg/L per year.
- During the current audit at E203 the median conductivity was 0.390 mS/cm; 61% of recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was within the range of values recorded in the previous three audits that had available data (median values ranged from 0.363 to 0.484 mS/cm). A significant long-term trend was detected with conductivity decreasing by 0.017 mS/cm per year.
- For E203 the median chlorophyll à concentration was 3.1 µg/L for the current audit; 31% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was greater than or equal to the previous three audits that had available data (median values ranged from 2.0 to 3.1 µg/L). A significant long-term trend was detected for chlorophyll à with concentrations increasing by 0.12 µg/L per year.

E206 - approximately 5 km downstream of the Nattai River and Gibbergunyah Creek confluence

- The median TN concentration for E206 was 1.050 mg/L during the current audit; all recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.980 to 2.065 mg/L). A significant long-term trend was detected with concentrations decreasing by 0.022 mg/L per year.
- During the current audit the median TP concentration for E206 was 0.022 mg/L; 64% of recordings above the ANZECC guideline for upland rivers. The median TP concentration during the current audit was noticeably lower than the previous audits (median values for previous five audits ranged from 0.040 to 0.550 mg/L). Despite this a significant long-term trend was detected for TP with concentrations increasing by 0.002 mg/L per year.
- The median electrical conductivity for E206 was 0.333 mS/cm during the current audit; 47% of recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was within the range of values recorded in previous audits (median values for five previous audits ranged from 0.185 to 0.356 mS/cm). There was no significant long-term trend detected for electrical conductivity at E206.
- The median chlorophyll à concentration for E206 was 2.3 µg/L during the current audit; 11% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 1.4 to 7.5 µg/L). No significant long-term trend was detected for chlorophyll à at E206.

E210 - located in the lower Nattai approximately 4 km upstream of the Nattai and Little River confluence

- The median TN concentration for E210 was 0.350 mg/L during the current audit; 78% of recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was within the range of values recorded in previous

audits (median values for previous five audits ranged from 0.290 to 0.740 mg/L) No significant long-term trend in TN was detected.

- The median TP concentration for E210 was 0.011 mg/L during the current audit; 17% of recordings exceeding the ANZECC guideline for upland rivers. Overall, the median TP concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.005 to 0.046 mg/L). A significant long-term trend in TP was detected although this was only minor with concentrations increasing at <0.001 mg/L per year.
- The median conductivity for E210 during the current audit was 0.289 mS/cm; 6% of recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was generally similar to the previous five audits (median values ranged from 0.183 to 0.306 mS/cm). A significant long-term trend was detected with conductivity increasing by 0.006 mS/cm per year.
- For E210 the median chlorophyll à concentration during the current audit; 2.3 µg/L and 22% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 1.3 to 2.5 µg/L). Despite this, a significant long-term trend was detected with chlorophyll à increasing by 0.06 µg/L per year.

Storage water quality

Not available.

1.11 Upper Nepean River

1.11.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Upper Nepean River sub-catchment are shown Figure I 1-43.

Land use in the Upper Nepean River sub-catchment is dominated by Conservation and Natural Environments (85.8%) yet unlike many other northern region sub-catchments Managed resource protection (81.8%) is the primary tertiary land use of this class. Production form Dryland Agriculture and Plantations (7.9%) is the second most extensive land use class in the sub-catchment and this is mostly attributed to Grazing modified pastures (7.8%). Several reservoirs are located in the Upper Nepean sub-catchment including Cataract, Cordeaux and Avon reservoirs and Water covers a considerable portion (3.6%) of the Upper Nepean sub-catchment which includes both reservoirs (3.3%) and rivers (0.3%). Intensive Uses (2.3%) is mixed among several tertiary land use classes the greatest of which are Transport and communication (0.76%) and Utilities (0.65%).

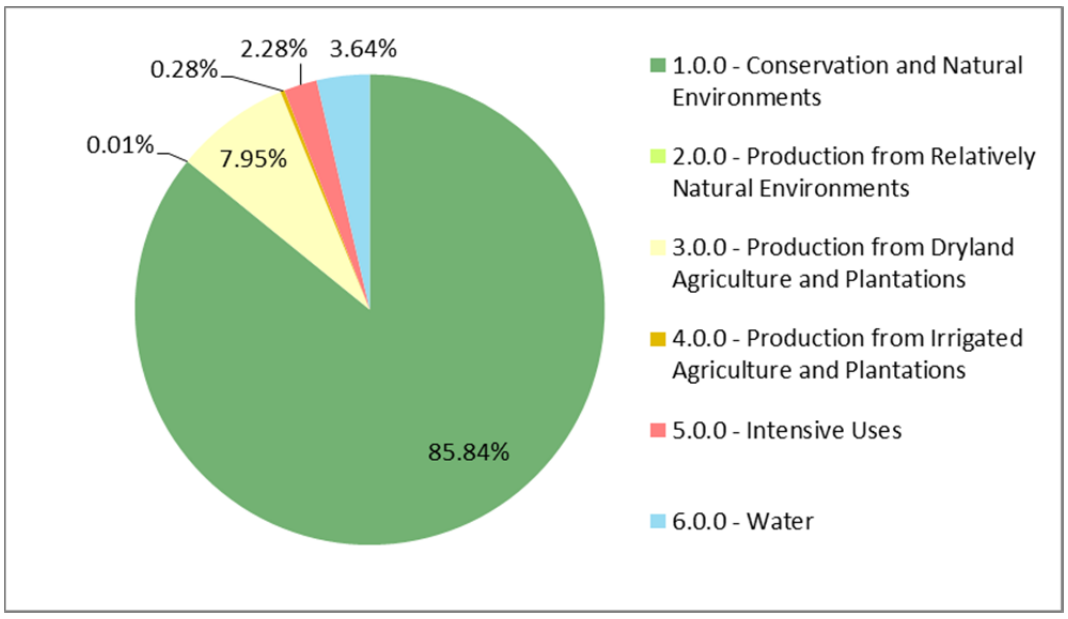


Figure I 1-40 Land use in the Upper Nepean River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Upper Nepean River sub-catchment were sourced from the SCA macroinvertebrate monitoring programs and OEH. The results are summarised in Figure I 1-41, Figure I 1-42, Figure I 1-43 and Table I 1-23.

Data on macroinvertebrates in the Upper Nepean sub-catchment was available from 31 sites, 11 of which had riffle habitat, with a total of 188 samples collected since 2001 and a further 22 historic samples totalling 200 samples in all.

The AUSRIVAS rating reference condition (band A) was the highest frequency accounting for approximately 45% of samples closely followed by significantly impaired (band B) which accounted for 41.5% of samples. A further 9% of samples were assessed as severely impaired

(band C), 4% as more biologically diverse than reference (band X) and 0.5% (one sample) as extremely impaired (band D).

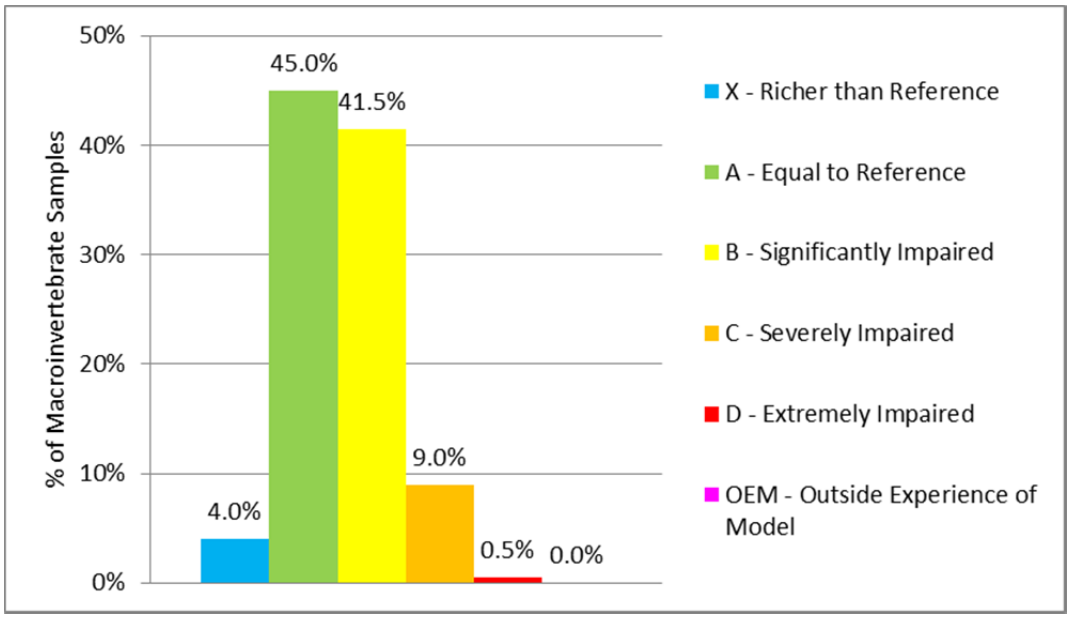


Figure I 1-41 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Upper Nepean River sub-catchment

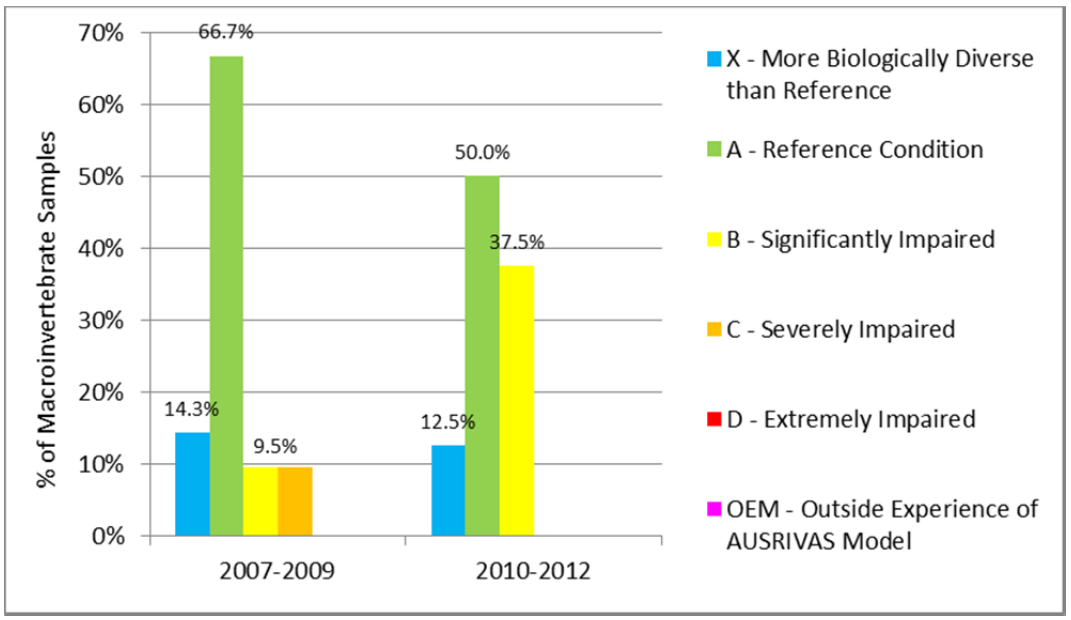
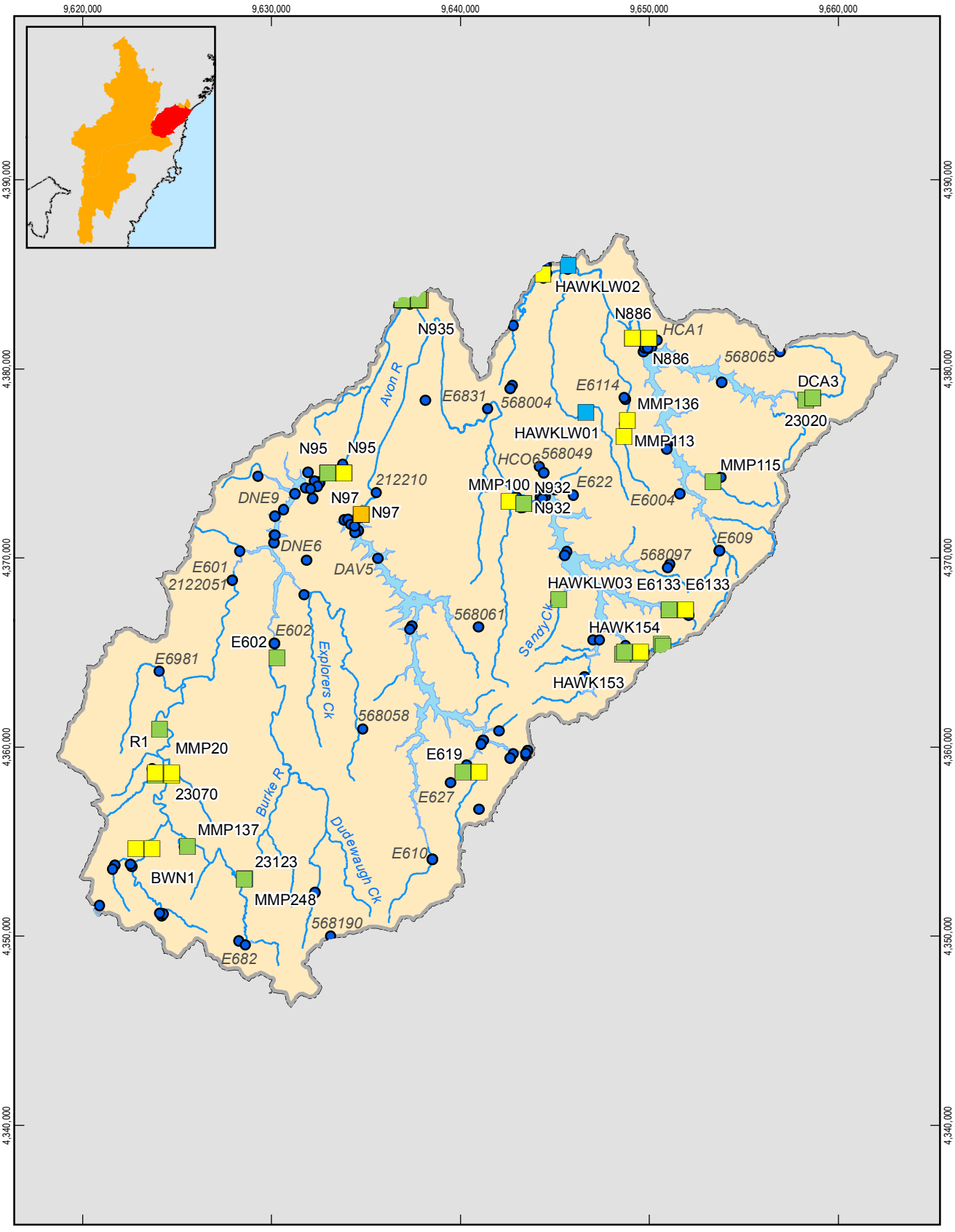


Figure I 1-42 Comparison of AUSRIVAS results from the Upper Nepean River sub-catchment: 2007-09 to 2010-12

Two core sites MMP20 and N935 (both with edge and riffle habitats) have been consistently assessed since 2002. AUSRIVAS scores at MMP20 have predominately been reference condition (band A) with more biologically diverse than reference (band X) ratings in 2006 and 2007. More recently this site has consistently scored a lower O/E 50 placing it in significantly impaired (band B) for all samples collected in 2011 and 2012.

AUSRIVAS scores at N935 have generally fluctuated between significantly impaired (band B) and reference condition (band A) but the most recent samples, collected in 2011, were all assessed as reference condition (band A) for both edge and riffle habitats.

Comparison of the AUSRIVAS results for the previous audit period to results provided for 2010 to 2012 for the Upper Nepean River sub-catchment reveals a decline in condition across the catchment (Figure I 1-42).



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model

Water Quality Monitoring Site

Waterbody

Waterway

Sub-catchment Boundary

Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

N

Sydney Catchment Authority
Catchment Audit 2013

Upper Nepean River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number 2314960
Revision 0
Date 26 Nov 2013

Figure I 1-43

N:\AU\Sydney\Projects\23\14960\GIS\Maps\Deliverables\23_14960_Appl002_MBSub-catchments_Rev0.mxd

Level 6, 20 Smith Street Parramatta NSW 2150 Australia T 61 2 8898 8800 F 61 2 8898 8810 E ptamail@ghd.com W www.ghd.com

Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

Table I 1-23 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Upper Nepean River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
23020	Edge	-34.28736	150.89532								A					
23070	Edge	-34.47719	150.5341										A			
23070	Riffle	-34.47719	150.5341										B			
23123	Edge	-34.52532	150.58211										X			
BWN1	Edge	-34.5125	150.52444				B									
BWN1	Riffle	-34.5125	150.52444				B									
DCA3	Edge	-34.28628	150.899361			B	B	A	C	A						
DCA3	Edge	-34.28628	150.899361	B		B	A	B	B	A						
E602	Edge	-34.419444	150.596389	B		B	A	B	A	A						
E6133	Edge	-34.38961	150.82682			A	A	A	X	A						
E6133	Edge	-34.38961	150.82682	B		A	B	A	A	A						
E6133	Riffle	-34.38961	150.82682			B										
E615	Edge	-34.232222	150.741667	B		B	C	B	B	B						
E619	Edge	-34.470556	150.711389	A		B	A	B	B	A						
E619	Riffle	-34.470556	150.711389	A				A	A	B						
HAWK151	Edge	-34.4065	150.8175	A												
HAWK152	Edge	-34.4074	150.8186	A												
HAWK153	Edge	-34.4116	150.8011	A												
HAWK153	Riffle	-34.4116	150.8011	A												
HAWK154	Edge	-34.4107	150.8022	A												
HAWK154	Riffle	-34.4107	150.8022	B												
HAWKLW01	Edge	-34.29729	150.76931										A		X	
HAWKLW02	Edge	-34.22735	150.75594										A		X	
HAWKLW03	Edge	-34.3869	150.75747										A		A	
MMP100	Edge	-34.3411	150.7267					A								B
MMP113	Edge	-34.30794	150.79164					B								
MMP115	Edge	-34.32807	150.84378					A								
MMP136	Edge	-34.30036	150.7932						X							B
MMP137	Edge	-34.51089	150.54849							A						
MMP20	Edge	-34.47627	150.5343			A	B	A	flooded	X	X	A	A		B	B
MMP20	Riffle	-34.47627	150.5343					A			A	A			B	B
MMP248	Edge	-34.52559	150.58186									A				

Table I 1-23 (cont.) AUSRIVAS ranking of macroinvertebrate monitoring sites in the Upper Nepean River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
N886	Edge	-34.26097	150.800194			B	B	B	B	C						
N886	Edge	-34.26097	150.800194	C		B	A	B	B	B						
N886	Riffle	-34.26097	150.800194			B										
N886	Riffle	-34.26097	150.800194	C		B	C			C						
N92	Edge	-34.24684	150.66798		A	A										
N92	Riffle	-34.24684	150.66798	C	D	C	C	C	B	C						
N93	Edge	-34.24375	150.66633			A	B	B	A	A						
N93	Edge	-34.24375	150.66633	A		A	B	A	B	B						
N932	Edge	-34.341944	150.735556			A	B	B	A	A						
N932	Edge	-34.341944	150.735556	B		A	B	A	B	A						
N935	Edge	-34.24647	150.66693			A	B	A	B	B					A	
N935	Edge	-34.24647	150.66693			A	B	B	A	A					A	
N935	Edge	-34.24647	150.66693	A			A	A	A	A	A	C	A		A	
N935	Riffle	-34.24647	150.66693					B							A	
N935	Riffle	-34.24647	150.66693			B	B	B							A	
N935	Riffle	-34.24647	150.66693			B	B	B	B						A	
N935	Riffle	-34.24647	150.66693	B			B	B			A	C	B		A	
N95	Edge	-34.33023	150.6276								X					
N95	Edge	-34.33023	150.6276			A	A	A	A	A						
N95	Edge	-34.33023	150.6276	B		A	A	A	A	A						
N95	Riffle	-34.33023	150.6276			B	B	B								
N95	Riffle	-34.33023	150.6276	B							A					
N97	Edge	-34.349581	150.642036			B	B	B	B	C						
N97	Edge	-34.349581	150.642036	B		C	B	B	C	C						
R1	Edge	-34.45533	150.530166		A											

Water availability

Surface water flow

Flow data from fourteen gauges within the Upper Nepean River sub-catchment was considered under this current audit. These gauges are located both upstream and downstream of the major dams within the sub-catchment. The assessment of these gauges is consistent with previous audits. Table I 1-24 identifies the gauges assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-24 Flow (ML/day) at gauging stations in the Upper Nepean River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
Upstream of Nepean Dam							
2122341	Glenquarry Creek at Alcorns	06/04/2003	12.22	81.34	123.16	1.03	3.92
212209	Nepean River at McGuires Crossing	06/02/1970	37.12	23.73	104.48	36.62	53.77
2122051	Nepean River at Nepean Dam Inflow	18/02/1990	30.63	27.17	107.35	25.54	56.84
2122052	Burke River at Nepean Dam Inflow	19/02/1990	11.18	7.70	5.17	7.69	17.24
Downstream of Nepean Dam							
212204	Nepean River at Avon Dam Road	24/07/1986	64.00	15.12	20.88	11.11	140.57
212203	Nepean River at Pheasants Nest	17/11/1983	1.74	8.03	243.00	205.52	395.05
Upstream of Avon Dam							
2122111	Avon River at Summit Tank	29/03/1990	4.59 [1]	N/A [1]	4.98 [1]	2.72	6.71
2122112	Flying Fox No3 Creek at Upper Avon	27/06/1990	0.53 [1]	N/A [1]	0.75 [1]	0.41	0.71
Downstream of Avon Dam							
212210	Avon River at Avon Weir	27/06/1969	1.87	0.74	0.46	9.31	11.34

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
Upstream of Cordeaux Dam							
2122201	Goondarrin Creek at Kemira D'Cast	03/08/1991	1.27 [2]	N/A [2]	1.64 [2]	0.46	0.83
Downstream of Cordeaux Dam							
212221	Cordeaux River at Cordeaux Weir	18/07/1990	13.82	7.70	6.86	10.40	35.91
Upstream of Cataract Dam							
2122322	Loddon River at Bulli Appin Road	09/03/1990	5.56	4.31	3.22	6.42	8.13
Downstream of Cataract Dam							
212231	Cataract River at Jordan's Crossing	09/11/1967	127.08	149.31	77.66	121.87	164.98
212233	Cataract River at Brighton's Pass Weir	16/03/1983	0.00	0.00	0.00	0.00	12.39

Notes:

1. Data capture for 2122111 and 2122112 started on 21/02/2007 and so no data was available for the 2001-2004 audit period and a small quantity of data for the 2004-2007 audit period.
2. Data capture for 2122201 started on 25/02/2007 and so no data was available for the 2001-2004 audit period and a small quantity of data for the 2004-2007 audit period.

Flows in Glenquarry Creek at Alcorns (monitor 2122341) were significantly less than the long-term average (median 3.92 ML/day vs. long-term 12.22 ML/day) but slightly elevated over the previous 2007-2010 audit period. The audit periods of 2001-2004 and 2004-2007 recorded flows well above the long-term median. All audit periods assessed had large sections of time where no flows were recorded (68% in 2001-2004, 16% in 2004-2007, 23% in 2007-2010 and 9% in 2010-2013).

Flows in the Nepean River at McGuires Crossing (monitor 212209) were slightly lower than average for the current audit period (although the median was higher 53.77 ML/day vs. long-term 37.12 ML/day) with a general trend of an increase in flows through the audit periods, the only exception in the 2004-2007 audit period where the flows are well above the long-term trend. All audit periods had sections of time where no flows were recorded (2001-2004, 6%, 2004-2007, 9%, 2007-2010, 17%, and 2010-2013, 7%).

Flows in the Nepean River at Nepean Dam Inflow (monitor 2122051) were higher than the long-term average (median 56.84 ML/day vs. long-term 30.63 ML/day). No obvious trend over the audit periods is present, however, the 2007-2007 audit showed flows well above the long-term trend and that of all other audit periods. The current audit period was the only one of the audit

periods assessed where there were no days of no flow recorded (2001-2004 had 21% of days with no recorded flow).

Flows in the Burke River at Nepean Dam Inflow (monitor 2122052) were above the long-term average (median 17.24 ML/day vs. long-term 11.18 ML/day). This is against the general trend of previous audit periods that are all below the long-term trend. The 2007-2010 audit period and the current audit period had complete data sets with no days of zero flow recorded.

Flows in the Nepean River at Avon Dam Road (monitor 212204) were slightly lower than the long-term average (however the median was higher, 140.57 ML/day vs. long-term 64 ML/day). No obvious trend across the audit periods has been captured for this monitor.

Flows in the Avon River at Summit Tank (monitor 2122111) were above the long-term average (median 6.71 ML/day vs. long-term 4.59 ML/day). This is consistent with a general trend of an increase in flows across the audit periods. Data capture for this location started on 21/02/2007 and so no data was available for the 2001-2004 audit period and a small quantity of data (6%) for the 2004-2007 audit period.

Flows in Flying Fox No 3 Creek at Upper Avon (monitor 2122112) were slightly below the long-term average (however the median was higher, 0.71 ML/day vs. long-term 0.53 ML/day). The flows were consistent with the general trend for this monitoring location. Data capture for this location started on 21/02/2007 and so no data was available for the 2001-2004 audit period and a small quantity of data (12%) for the 2004-2007 audit period.

Flows in the Avon River at Avon Weir (monitor 212210) were well below the long-term average (since the records commenced) but above the average for the other audit periods considered in this audit. The general trend over the audit periods through to the current audit is an increase in flows recorded at this monitor.

Flows in the Goondarrin Creek at Lemira D'Cast (monitor 2122201) were consistent with the long-term average (2.51 ML/day vs. long-term 2.50 ML/day, median 0.83 ML/day vs. long-term 1.27 ML/day). No obvious trend is identifiable at this monitoring location. Data capture for this location started on 25/02/2007 and so no data was available for the 2001-2004 audit period and a small quantity of data (12%) for the 2004-2007 audit period.

Flows in Cordeaux River at Cordeaux Weir (monitor 212221) were slightly above the long-term average (median 35.91 ML/day vs. long-term 13.82 ML/day). This is consistent with a general trend across the audit periods of an increase in flows.

Flows in Loddon River at Bulli Appin Road (monitor 2122322) were above the long-term average (median 8.13 ML/day vs. long-term 5.56 ML/day). The general trend across the audit periods is an increase in average daily flows although a drop between the 2001-2004 audit period and the 2004-2007 audit period was noted.

Flows in Cataract River at Jordan's Crossing (monitor 212231) were slightly lower than the long-term average (although an increase in the median was noted 164.98 ML/day vs. long-term 127.08 ML/day). The general trend across the audit periods is an increase in average daily flows although a drop between the 2001-2004 audit period and the 2004-2007 audit period was noted.

Flows in the Cataract River at Brighton's Pass Weir (monitor 212233) were slightly below the long-term average but well above the average daily flows of the previous audit periods. The dataset for this monitor contained a large number of days where no flow was recorded across all audit periods. The data record for the current audit period ceased on 13/5/2013 creating a slightly shorter audit period.

Environmental flows

From the data received and considered as part of this audit it was identified that there are six structures of importance to environmental flows within the Upper Nepean Sub-catchment. These are as follows:

- Cataract Dam;
- Cordeaux Dam;
- Avon Dam;
- Nepean Dam;
- Brighton's Pass Weir;
- Pheasants Nest Weir.

Table I 1-25 provides a summary of the environmental flows from the above structures for the current audit period and also the previous audit periods for consideration of the long term trends.

Table I 1-25 Summary of environmental flows for the Upper Nepean sub-catchment

Structure	Total Flow (ML)			Median Flow (ML/day)				Average Flow (ML/day)			
	Current Audit Period	07-10 Audit Period	04-07 Audit Period	Current Audit Period	07-10 Audit Period	04-07 Audit Period	Long Term 2004-2013	Current Audit Period	07-10 Audit Period	04-07 Audit Period	Long Term 2004-2013
Cataract Dam	56,260	1,705	1,274	22	1	1	1	51	2	1	18
Cordeaux Dam	25,852	3,206	3,921	10	3	3	3	24	3	4	10
Avon Dam	34,837	15,600	0	10	10	0	2	32	14	0	15
Nepean Dam	54,385	5,989	7,808	27	6	6	6	50	5	7	21
Brighton's Pass Weir	66,948	2,130	1,352	30	2	1	2	61	2	1	21
Pheasants Nest Weir [1]	126,576	19,135	7,805	52	22	6	22	115	17	7	47

Note:

1. The release of flow from Pheasants Nest Weir excludes the flows transferred to Brighton's Pass Weir. For these flows see the section on Bulk Water Transfers for this sub-catchment.

Catchment water quality

Long-term water quality monitoring in the Upper Nepean River catchment is undertaken by the SCA at: the Nepean River inflow to Lake Nepean (E601); the Burke River Inflow to Lake Nepean (E602); and the Nepean River at McGuires Crossing (E697). Water quality data for Sandy Creek at Fire Road 6C (E6006), Flying Fox No. 3 Creek at Fire Road No. 15 (E604), Goondarin Creek at vent shaft (E608), Cataract River downstream of Angels Creek (E609), the Avon River at Summit Track (E610) and Cordeaux River crossing between Upper Cordeaux 1 & 2 (E680) were also analysed for the current audit period. However, water quality conditions for E6006, E604, E608, E609, E610 and E680 were not made available during previous audits and no comparisons to previous audits have been made.

There is limited water quality data for streams that flow into Lake Avon, Lake Cordeaux and Lake Cataract, although given the protected nature of the catchments (i.e. almost wholly within Special Areas) water quality is usually very good. Historic water quality data at a number of these inflowing streams are available in the SCA's water quality database.

E601- Nepean River inflow to Lake Nepean

- The median chlorophyll à concentration for E601 was 1.1 µg/L during the current audit; a small number of samples (6%) exceeded the ANZECC Guideline for upland freshwater rivers. However, this median was higher than in all other audit periods from 1998 to 2010 (median values for previous three audits ranged from 0.4 to 0.4 µg/L), except one; during 195-98, the medial Chl-a level was high at 4.3 µg/L. Despite the relatively low recent concentrations, the long-term trend analysis detected a significant increasing trend with concentrations increasing by 0.02 µg/L per year.
- The median TN level for E601 was 0.475 mg/L during the current audit; 92% of records exceeded the ANZECC Guideline for upland rivers. This median TN was lower than for all previous audits up to 2004 (values for three audits from 1995 to 2004 ranged from 0.52 to 0.66 mg/L); and was also lower than the 2007-10 audit median TN (0.24 mg/L). Based on long term data, there has been a significant decreasing trend with concentrations decreasing by 0.011 mg/L per year.
- At E601, during the current audit, the median TP concentration was 0.014 mg/L; 22% of measurements above the ANZECC Guideline for upland rivers. This median TP level was comparable with results of the previous audits (median values for previous four audits ranged from 0.003 to 0.021 mg/L). Long-term trend analysis in the current audit did not detect any significant trend for TP at E601.
- At E601, the median EC level was 0.107 mS/cm during the current audit; none of the measurements exceeded the ANZECC Guideline for upland rivers. This result was similar to those of previous audit periods (median values for previous four audits ranged from 0.095 to 0.105 mS/cm). This was confirmed by long-term trend analysis, which did not detect any significant trend for EC at E601.

E602 - Burke River Inflow to Lake Nepean (E602)

- For E602, the median chlorophyll à concentration during the current audit was 0.4 µg/L; no recordings exceeded the ANZECC Guideline for upland rivers. This median was within the range of concentrations detected in five previous audits, which ranged from 0.1 to 0.4 µg/L). However, in the current audit, long-term trend analysis detected a significant increasing trend with chlorophyll à levels increasing by 0.01 µg/L per year.

- The median TN concentration for E602 was 0.075 mg/L during the current audit; only 8% of recordings exceeded the ANZECC Guideline for upland rivers. This median TN was lower than for all five previous audits, which ranged from 0.140 to 0.200 mg/L; and the current audit detected a significant decreasing trend of TN by 0.002 mg/L per year.
- During the current audit, the median TP concentration for E602 was 0.010 mg/L; 11% of measurements above the ANZECC Guideline for upland rivers. This median TP was only slightly higher than in the previous audits (median values for previous five audits ranged from 0.005 to 0.009 mg/L). A significant increasing trend was detected for TP at E601 by the trend analysis, although the magnitude of the trend was only minor with concentrations increasing by <0.001 mg/L per year.
- At E602, the median EC during the current audit was 0.077 mS/cm; none of the measurements exceeded the ANZECC Guideline for upland rivers. This result was similar to the previous five audits (median values ranged from 0.057 to 0.075 mS/cm), although a significantly decreasing trend was detected by long-term trend analysis, with EC decreasing by 0.001 mS/cm per year.

E697 - Nepean River at McGuires Crossing

- For E697, during the current audit period, the median chlorophyll à concentration was 2.5 µg/L; only 19% of samples exceeded the ANZECC Guideline for upland rivers. This median chlorophyll à concentration was within the range of concentrations detected in previous audits (median values for previous three audits ranged from 1.9 to 5.8 µg/L). Based on the long term data, a significant decreasing trend was detected at E697 for chlorophyll à with concentrations decreasing by 0.29 µg/L per year.
- For E697, the median TN concentration for the current audit was 0.530 mg/L; 97% of samples exceeded the ANZECC Guideline for upland rivers. This median was greater than in the previous audits, which ranged from 0.375 to 0.40 mg/L. The long term data analyses in the current audit indicated a significant trend with concentrations increasing by 0.014 mg/L per year.
- At E697, the median TP concentration was 0.018 mg/L during the current audit; 39% of records exceeding the ANZECC Guideline for upland rivers. The median TP concentration during the current audit was slightly higher than the previous three audits where data was available (median values ranged from 0.010 to 0.016 mg/L). The TP concentrations were found to be increasing at E697 although the rate of change was again only minor at <0.001 mg/L per year.
- During the current audit, at E697, the median EC was 0.096 mS/cm and there were again no recordings, which exceeded the ANZECC Guideline for upland rivers. The median EC levels were similar during all previous audit periods (median values ranged from 0.091 to 0.098 mS/cm); and based on all long term data, no significant trend was detected.

E6006 - Sandy Creek at Fire Road 6C

- For E6006 the median TP concentration during the current audit was 0.014 mg/L and 23% of recordings exceeded the ANZECC guideline for upland rivers. A significant long-term trend was detected although this was only minor with concentrations increasing at 0.001 mg/L per year.
- The median TN concentration at E6006 during the current audit was 0.330 mg/L and 55% of recordings exceeded the ANZECC guideline for upland rivers. A significant long-term trend was detected with concentrations decreasing by 0.006 mg/L per year.

- For E6006 during the current audit the median electrical conductivity was 0.243 mS/cm and 23% of recordings exceeding the ANZECC guideline for upland rivers. A significant long-term trend was detected with conductivity decreasing by 0.003 mS/cm per year.
- The median chlorophyll à concentration was 0.6 µg/L for E6006 during the current audit and 12% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. No significant long-term trend was detected for chlorophyll à.

E604 - Flying Fox No. 3 Creek at Fire Road No. 15

- The median TP concentration during the current audit at E604 was 0.020 mg/L and 40% of recordings exceeded the ANZECC guideline for upland rivers. No long-term significant trend in TP was detected.
- For E604 the median TN concentration during the current audit was 0.260 mg/L and 51% of recordings exceeded the ANZECC guideline for upland rivers. No significant long-term trend was detected.
- During the current audit the median electrical conductivity for E604 was 0.140 mS/cm and no recordings exceeding the ANZECC guideline for upland rivers. A significant long-term trend was detected with conductivity increasing by 0.002 mS/cm per year.
- For E604 the median chlorophyll à concentration was 0.4 µg/L during the current audit and no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. A significant long-term trend was detected for chlorophyll à but this was only minor with concentrations increasing by <0.01 µg/L per year.

E608 - Goondarin Creek at vent shaft (E608)

- For E608 the median TP concentration during the current audit was 0.010 mg/L and 29% of recordings exceeded the ANZECC guideline for upland rivers. A significant long-term trend was detected although this was only minor with concentrations increasing at 0.001 mg/L per year.
- The median concentration of TN at E608 during the current audit was 0.250 mg/L and 48% of recordings exceeded the ANZECC guideline for upland rivers. No significant long-term trend was detected.
- For E608 during the current audit the median electrical conductivity was 0.130 mS/cm and no recordings exceeding the ANZECC guideline for upland rivers. A significant long-term trend was detected with conductivity decreasing by 0.005 mS/cm per year.
- The median chlorophyll à concentration was 0.4 µg/L for E608 during the current audit and 2% recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. A significant long-term trend was detected for chlorophyll à with concentrations increasing by 0.02 µg/L per year.

E609 - Cataract River downstream of Angels Creek

- For E609 the median TP concentration during the current audit was 0.010 mg/L and 32% of recordings exceeded the ANZECC guideline for upland rivers. A significant long-term trend was detected with concentrations increasing at 0.002 mg/L per year.
- For E609 the median TN concentration during the current audit was 0.180 mg/L and 41% of recordings exceeded the ANZECC guideline for upland rivers. No significant long-term trend was detected.

- During the current audit the median electrical conductivity for E609 was 0.140 mS/cm and no recordings exceeding the ANZECC guideline for upland rivers. A significant long-term trend was detected with conductivity increasing by 0.003 mS/cm per year.
- The median chlorophyll à concentration was 0.40 µg/L for E609 during the current audit and 5% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. No significant long-term trend was detected for chlorophyll à.

E610 - Avon River at Summit Track

- The median TP concentration during the current audit at E610 was 0.010 mg/L and 14% of recordings exceeded the ANZECC guideline for upland rivers. A long-term significant trend in TP was detected although this was only minor with concentrations increasing by <0.001 mg/L per year.
- The median TN concentration at E610 during the current audit was 0.130 mg/L and 11% of recordings exceeded the ANZECC guideline for upland rivers. A significant long-term trend was detected with concentrations decreasing by 0.005 mg/L per year.
- For E610 during the current audit the median electrical conductivity was 0.090 mS/cm and no recordings exceeding the ANZECC guideline for upland rivers. A significant long-term trend was detected with conductivity decreasing by 0.003 mS/cm per year.
- For E610 the median chlorophyll à concentration was 0.30 µg/L during the current audit and no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. No significant long-term trend was detected for chlorophyll à.

E680 - Cordeaux River crossing between Upper Cordeaux 1 & 2

- The median TP concentration during the current audit at E680 was 0.009 mg/L and 14% of recordings exceeded the ANZECC guideline for upland rivers. A long-term significant trend in TP was detected although this was only minor with concentrations increasing by <0.001 mg/L per year.
- For E680 the median TN concentration during the current audit was 0.130 mg/L and 11% of recordings exceeded the ANZECC guideline for upland rivers. A significant long-term trend was detected with concentrations decreasing by 0.008 mg/L per year.
- The median electrical conductivity at E680 during the current audit was 0.094 mS/cm and no recordings exceeding the ANZECC guideline for upland rivers. A significant long-term trend was detected although this was only minor with conductivity decreasing by 0.001 mS/cm per year.
- The median chlorophyll à concentration was 0.300 µg/L for E680 during the current audit no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. A significant long-term trend was detected for chlorophyll à with concentrations increasing by 0.10 µg/L per year.

Storage water quality

Long-term monitoring also takes place in the reservoirs at: Lake Cataract (DCA1); Lake Cordeaux (DCO1); Lake Avon (DAV1, DAV6, DAV7); and Lake Nepean (DNE2; DNE7). Historic water quality data at a number of other dam locations are also available in the SCA's water quality database. However, there was no data made available to the auditor for DAV6 and DNE7 for the current audit period.

DCA1 – Lake Cataract

- The median TN concentration for DCA1 was 0.190 mg/L during the current audit; 6% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was slightly lower than previous audits (median values for previous five audits ranged from 0.200 to 0.240 mg/L) and a significant long-term trend was detected with concentrations decreasing by 0.003 mg/L per year.
- The median TP concentration for DCA1 was 0.006 mg/L during the current audit; 29% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was slightly greater than previous audits (median values for all previous five audits were 0.005 mg/L). A significant long-term trend was detected although this was only minor with concentrations increasing by <0.001 mg/L per year.
- The median electrical conductivity for DCA1 was 0.022 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was lower than previous audits (median values for previous five audits ranged from 0.067 to 0.081 mS/cm). A significant long-term trend was detected although this was only minor with conductivity increasing by only 0.001 mS/cm per year.
- The median chlorophyll à concentration for DCA1 was 3.0 µg/L during the current audit; 27% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 2.8 to 4.8 µg/L). A significant long-term trend was detected with chlorophyll à decreasing by 0.1 µg/L per year.

DCO1 - Lake Cordeaux

- For DCO1 the median TN concentration was 0.240 mg/L during the current audit; 2% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was lower than previous audits (median values for previous five audits ranged from 0.250 to 0.310 mg/L) and a significant long-term trend was detected with concentrations decreasing by 0.002 mg/L per year.
- For DCO1 the median TP concentration was 0.009 mg/L during the current audit; 44% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was greater than all previous audits (median values for previous five audits ranged from 0.005 to 0.007 mg/L). No significant long-term trend was detected for TP at DCO1.
- For DCO1 the median electrical conductivity was 0.100 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was higher than previous audits (median values for previous four audits ranged from 0.071 to 0.088 mS/cm). A significant long-term trend was detected with conductivity increasing by 0.002 mS/cm per year.
- For DCO1 the median chlorophyll à concentration was 4.1 µg/L during the current audit; 27% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values from previous audits (median values for previous five audits ranged from 4.3 to 6.6

µg/L). A significant long-term trend was detected with chlorophyll à decreasing by 0.2 µg/L per year.

DAV1 - Lake Avon

- The median TN concentration for DAV1 was 0.160 mg/L during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was again lower than three previous audits with available data (median values for ranged from 0.200 to 0.250 mg/L) and a significant long-term trend was detected with concentrations decreasing by 0.006 mg/L per year.
- The median TP concentration for DAV1 was 0.002 mg/L during the current audit; 14% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was less than the three previous audits with available data (median values for previous audits ranged from 0.004 to 0.005 mg/L) although no significant long-term trend was detected.
- The median electrical conductivity for DAV1 was 0.079 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was again slightly more than previous audits (median values for previous three audits ranged from 0.067 to 0.071 mS/cm). A significant long-term trend was detected although this was only minor with conductivity increasing by 0.001 mS/cm per year.
- The median chlorophyll à concentration for DAV1 was 2.3 µg/L during the current audit; 1% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was again within the range of values from previous audits (median values for previous three audits ranged from 1.6 to 3.0 µg/L). A significant long-term trend was detected with chlorophyll à decreasing by 0.1 µg/L per year.

DAV7 - Lake Avon

- During the current audit the median TN concentration at DAV7 was 0.160 mg/L; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was less than previous audits (median values for previous five audits ranged from 0.190 to 0.200 mg/L) and a significant long-term trend was detected with concentrations decreasing by 0.006 mg/L per year.
- During the current audit the median TP concentration for DAV7 was 0.006 mg/L; 20% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was similar to previous audits (median values for previous five audits ranged from 0.005 to 0.006 mg/L). No significant long-term trend was detected for TP at DAV7.
- During the current audit the median electrical conductivity at DAV7 was 0.080 mS/cm; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was greater than previous audits (median values for previous four audits ranged from 0.050 to 0.074 mS/cm). Despite this, a significant long-term trend was detected with conductivity decreasing by 0.003 mS/cm per year.
- During the current audit period the median chlorophyll à concentration for DAV7 was 3.1 µg/L; 16% of recordings exceeded the ANZECC guideline for freshwater lakes and

reservoirs. The median chlorophyll à concentration during the current audit was less than values recorded in previous audits (median values for previous five audits ranged from 4.4 to 5.8 µg/L). Despite this, no significant long-term trend was detected for chlorophyll à at DAV7.

DNE2 - Lake Nepean

- For DNE2 the median TN concentration was 0.380 mg/L during the current audit; 69% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.310 to 0.410 mg/L). A significant long-term trend was detected with concentrations decreasing by 0.003 mg/L per year.
- For DNE2 the median TP concentration was 0.011 mg/L during the current audit; 51% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was slightly greater than previous audits (median values for previous five audits ranged from 0.005 to 0.009 mg/L). A significant long-term trend was detected although this was only minor with concentrations increasing by <0.001 mg/L per year.
- For DNE2 the median electrical conductivity was 0.092 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was greater than previous audits (median values for previous four audits ranged from 0.068 to 0.082 mS/cm). A significant long-term trend was detected although this was again only minor with conductivity increasing by 0.001 mS/cm per year.
- For DNE2 the median chlorophyll à concentration was 2.6 µg/L during the current audit; 18% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was less than the range of values from previous audits (median values for previous five audits ranged from 3.2 to 4.4 µg/L). No significant long-term trend was detected for chlorophyll à at DNE2.

1.12 Upper Wollondilly River

1.12.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Upper Wollondilly River sub-catchment are shown in Figure I 1-44.

Land use in the Upper Wollondilly River sub-catchment is dominated by Production form Dryland Agriculture and Plantations (86.5%) with the vast majority of this being Grazing modified pastures (85%). Conservation and Natural Environments (6%) was the second most extensive land use most of which was Other minimal use (5.7%). Intensive uses contributed a small portion of the land use across the sub-catchment and this was primarily contributed to Residential and farm infrastructure (3.8%). Water (1.9%) was only a small portion of the land use within the sub-catchment and this was primarily attributed to Reservoir (1.2%) which includes the Pejar and Sooley Reservoirs.

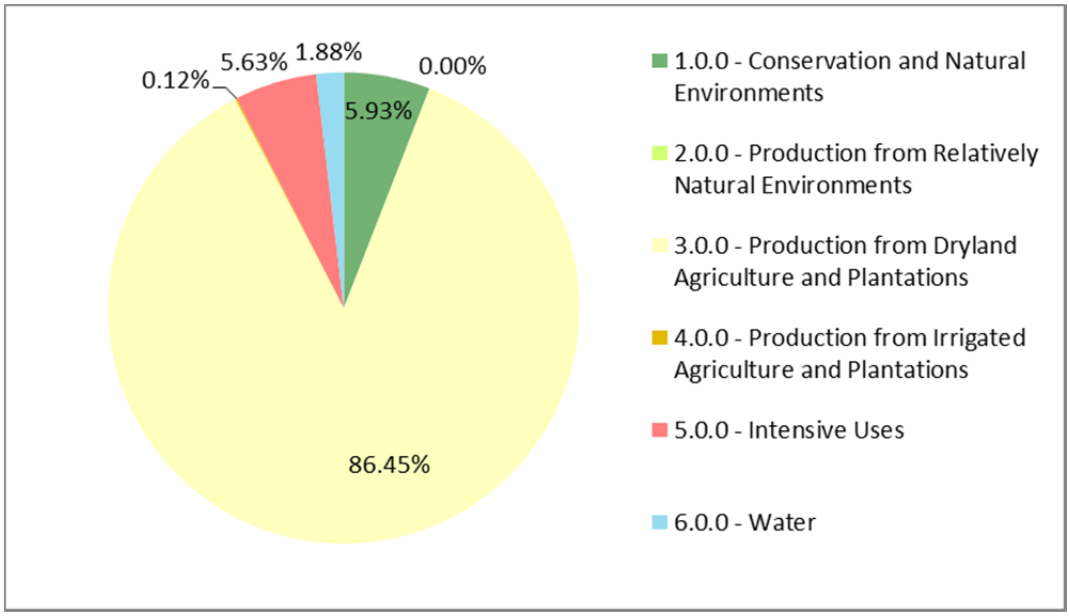


Figure I 1-44 Land use in the Upper Wollondilly River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Upper Wollondilly River sub-catchment were sourced from the SCA macroinvertebrate monitoring programs and OEH. The results are summarised Figure I 1-45, Figure I 1-47 and Table I 1-26.

A total of 13 sites have been sampled for macroinvertebrates including 12 sites since 2001 and 1 historic site. Thirty-five samples have been collected and all samples were collected from edge habitats which suggests that riffle habitat is uncommon in the Upper Wollondilly River sub-catchment.

The most common AUSRIVAS assessment for samples collected from the Upper Wollondilly sub-catchment is significantly impaired (band B) with O/E 50 scores for 40% of samples falling in this band, followed by reference condition (band A) (37.1%) 'more biologically diverse than reference (band X) (11.4%) and severely impaired (band C) (8.6%). Just one sample was

outside experience of the model (2.3%) which occurred at the long-term monitoring site (MMP27) in 2007.

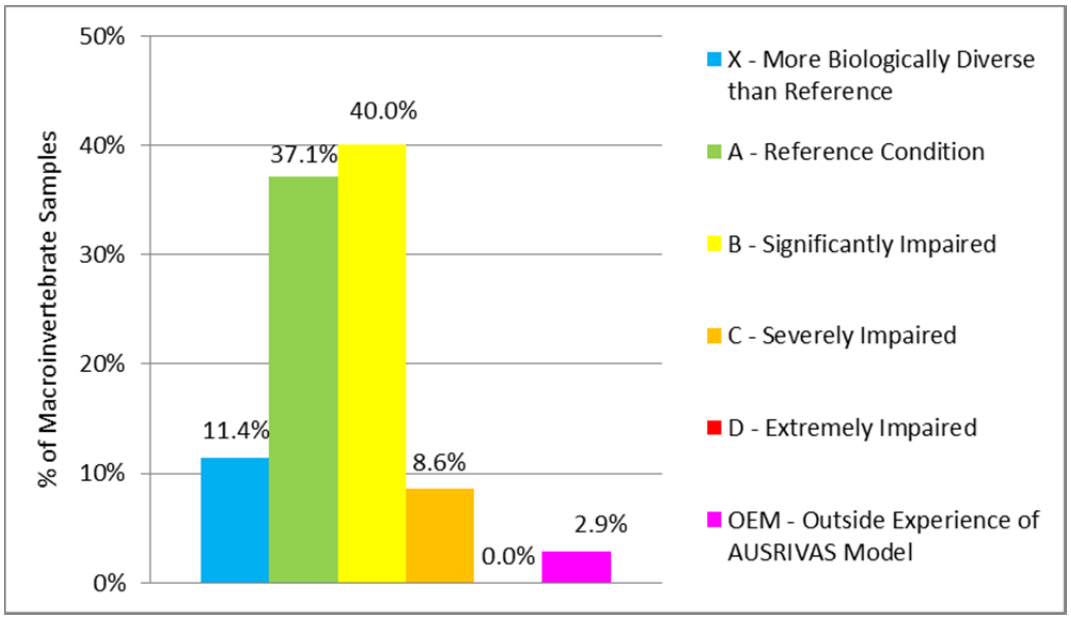


Figure I 1-45 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Upper Wollondilly River sub-catchment

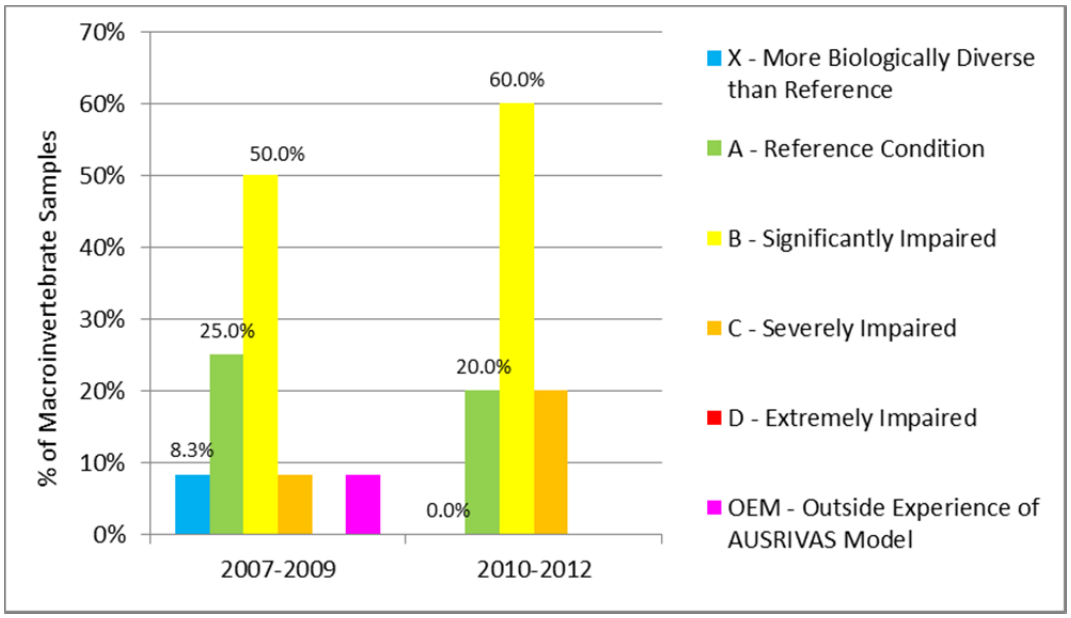


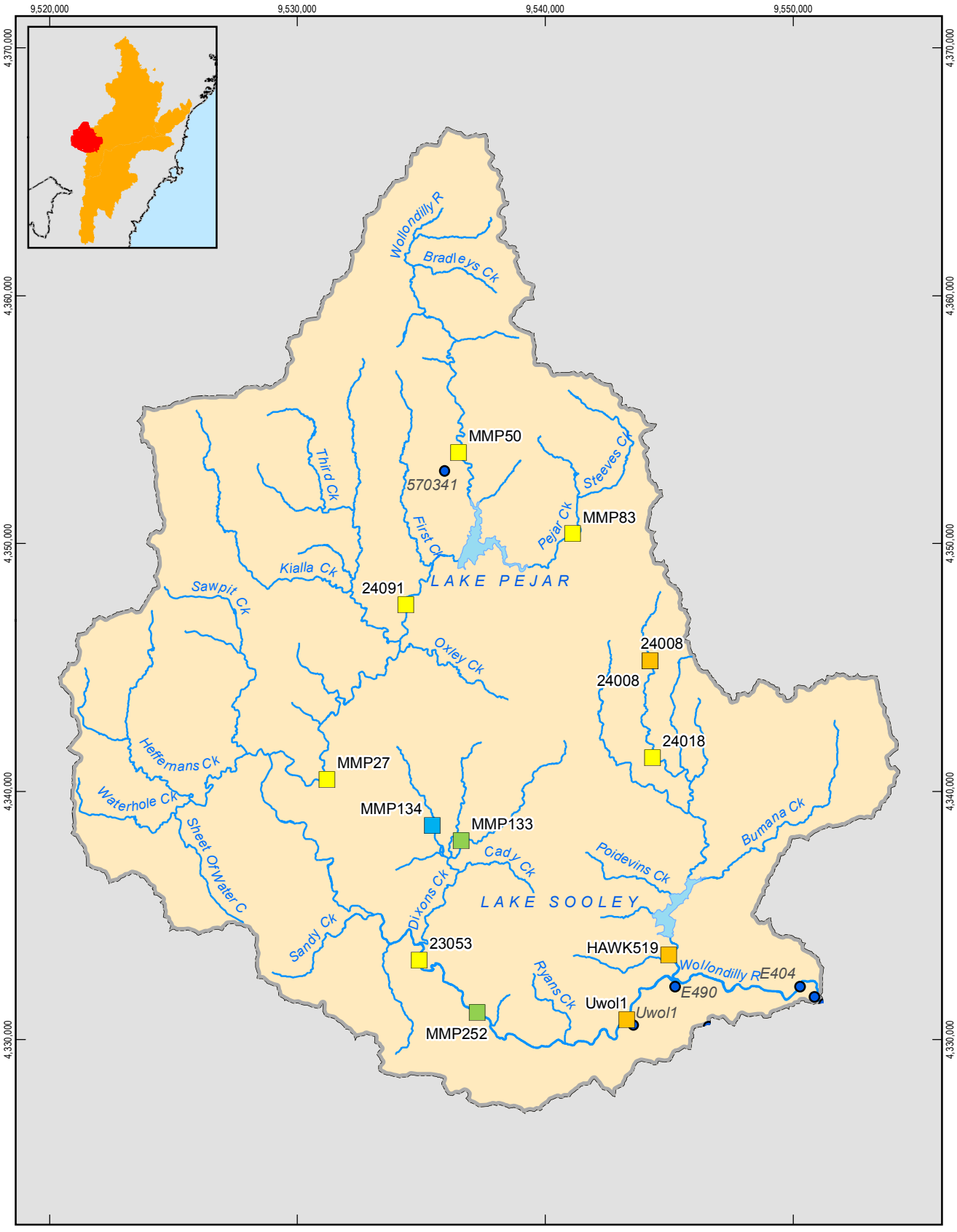
Figure I 1-46 Comparison of AUSRIVAS results from the Upper Wollondilly River sub-catchment: 2007-09 to 2010-12

MMP27 was the most consistently sampled site in the Upper Wollondilly sub-catchment with samples collected every year form 2001. Initially assessed as more biologically diverse than reference (band X) in 2001 this site has fluctuated over time, however the most recent sampling events and all three events to occur in this audit period (2010 to 2012) have resulted in this site assessed as significantly impaired (band B). In addition to MMP27 one other site (UWol1) was consistently sampled for macroinvertebrates in the Upper Wollondilly River sub-catchment but only one sample form this site was collected during this audit period in spring 2010 which was

assessed as severely impaired (band C) following a decline from reference condition (band A) in 2007.

Two core sites MMP27 and Uwol1 (both edge habitat only) have been assessed each year since 2001. AUSRIVAS scores at MMP27 have generally fluctuated between reference condition (band A) and more biologically diverse than reference (band X). The latest AUSRIVAS rating at this site (2009) was reference condition (band A). AUSRIVAS scores at Uwol1 have generally fluctuated between reference condition (band A) and significantly impaired (band B) which was the latest AUSRIVAS rating at this site (2009).

Comparison of AUSRIVAS results presented for the Upper Wollondilly River sub-catchment in the previous audit to those provided for the 2010 to 2012 period (Figure I 1-46) reveals a slight decline in AUSRIVAS assessment of condition across the sub-catchment. While 8.3% and 25% of sites were assessed as more biologically diverse than reference (band X) and reference condition (band A) respectively in the previous audit period, no sites were assessed as more biologically diverse than reference (band X) during the 2010 to 2012 period. This current period also observed a decline in sites ranked reference condition (band A) and an increase in sites ranked as significantly impaired (band B) during the most recent years of macroinvertebrate sampling and data for the Upper Wollondilly River sub-catchment.



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model

- *Water Quality Monitoring Site*
- Waterbody
- Waterway
- Sub-catchment Boundary
- Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

N

Sydney Catchment Authority
Catchment Audit 2013

Upper Wollondilly River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number 2314960
Revision 0
Date 26 Nov 2013

Figure I 1-47

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Level 6, 20 Smith Street Parramatta NSW 2150 Australia T 61 2 8898 8800 F 61 2 8898 8810 E ptamail@ghd.com W www.ghd.com

Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

Table I 1-26 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Upper Wollondilly River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
23053	Edge	-34.72908	149.56685								B					
24008	Edge	-34.6179	149.6652								B					
24008	Edge	-34.6179	149.6652								C					
24018	Edge	-34.65325	149.66738								B					
24091	Edge	-34.59984	149.55706										B			
HAWK519	Edge	-34.7248	149.6767	C												
MMP133	Edge	-34.68515	149.58405						A							
MMP134	Edge	-34.68005	149.57126							X						
MMP252	Edge	-34.74768	149.59283									A				
MMP27	Edge	-34.66412	149.52425		X	A	A	X	A	B	OEM	X	A	B	B	B
MMP50	Edge	-34.54403	149.57862			A		B								
MMP83	Edge	-34.57248	149.62978				B									
Uwol1	Edge	-34.74883	149.65896		A	A	A	B	A	B	A	B	B	C		
23167	Edge	-34.75672	149.56302												A	

Water availability

Surface water flow

Flow data from one gauge within the Upper Wollondilly River sub-catchment was considered under this current audit. This gauge was identified in the previous audit as a NOW gauge. For this audit the data was provided by SCA. The assessment of these gauges is consistent with previous audits. Data was also requested from Goulburn Mulwaree Council for inclusion in the audit and to retain consistency of approach with previous audits. This data was not made available. Table I 1-27 identifies the gauges assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-27 Flow (ML/day) at gauging stations in the Upper Wollondilly River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
212040	Kialla Creek at Pomeroy	10/06/1979	3.36	1.46	1.12	2.32	3.25

Flow in the Kialla Creek at Pomeroy during the audit period was approximately equal to the long-term average, albeit with slightly fewer low flow and zero-flow days. The median flow during the audit period was 3.25 ML/day, against a long-term average of 3.35 ML/day. Flows during the audit period were significantly higher on average than during the previous audit period (median flow 2.32 ML/day).

Catchment and storage water quality

Not available.

1.13 Wollondilly River

1.13.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Wollondilly River sub-catchment are shown in Figure I 1-48.

Similar to the Upper Wollondilly land use in the Wollondilly River sub-catchment is dominated by Production form Dryland Agriculture and Plantations (54.1%) with the vast majority of this being Grazing modified pastures (54.7%). Conservation and Natural Environments (40.9%) contributed a considerably larger proportion of the land use compared to the upper catchment, but was also the second most extensive land use in the sub-catchment. This was almost evenly split between Nature conservation (19.2%) and Other minimal use (20.0%). Intensive uses (3.7%) contributed a small portion of the land use across the sub-catchment and this was primarily contributed to Residential and farm infrastructure (2.0%). Water (1.2%) was only a small portion of the land use within the sub-catchment and this was primarily attributed to Reservoir (0.4%).

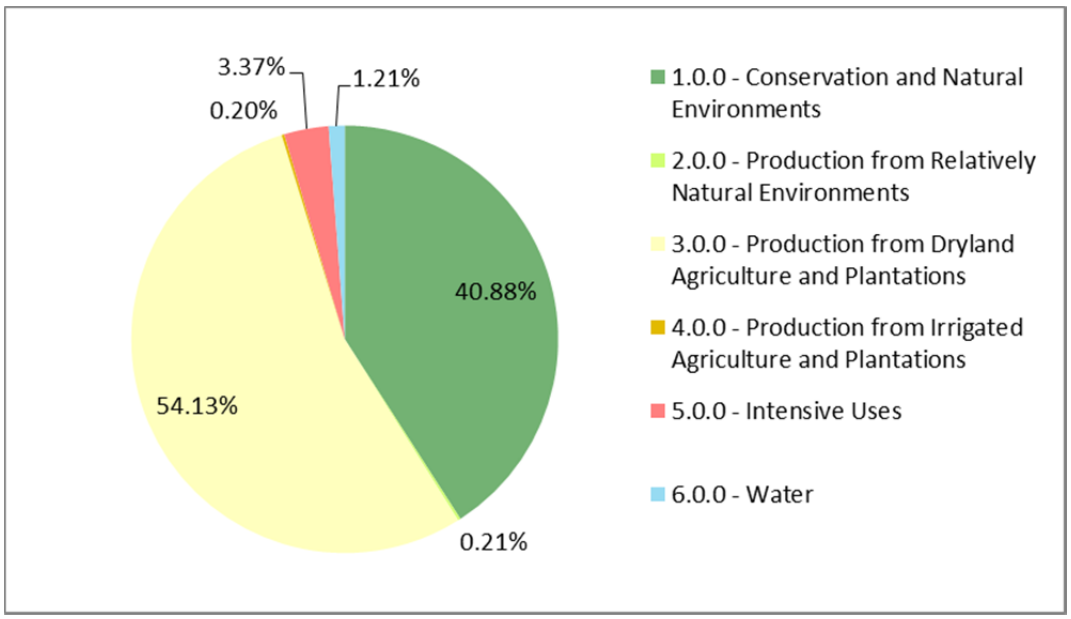


Figure I 1-48 Land use in the Wollondilly River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Wollondilly River sub-catchment were sourced from the SCA and OEH macroinvertebrate monitoring programs. The results are summarised in Figure I 1-49, Figure I 1-51 and Table I 1-28.

A total of 27 sites have been sampled for macroinvertebrates since 2001 and historic data for an additional five sites was also available, totalling 32 sites sampled across the Wollondilly River sub-catchment. Riffle habitats were sampled at only nine sites suggesting riffle is uncommon in the reaches of the Wollondilly River sub-catchment.

The majority of samples were assessed by AUSRIVAS to be significantly impaired (band B) (46.2%), followed by reference condition (band A) (36.9%), severely impaired (band C) (10.8%)

and one sample was assessed as more biologically diverse than reference (band X) (1.5%). An additional three samples were outside the experience of the model (OEM) (4.6%) and one sample could not be collected due to fires in the catchment.

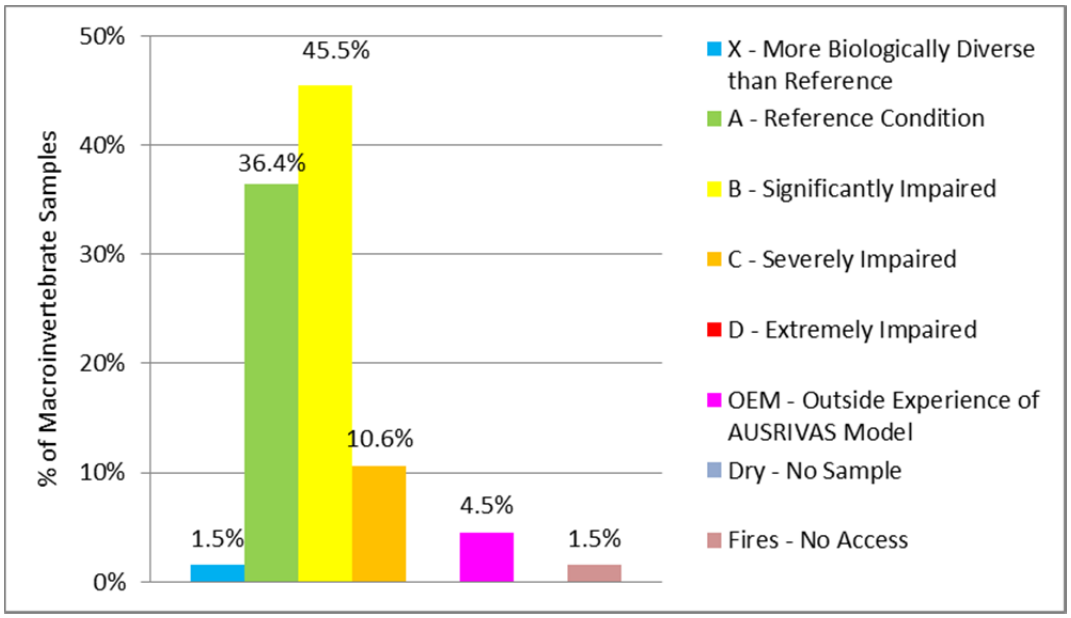


Figure I 1-49 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Wollondilly River sub-catchment

Two long-term monitoring sites have been consistently sampled by SCA since 2001 (A6 and E488) and although AUSRIVAS results of both sites have fluctuated over time these two sites have both been consistently assessed as significantly impaired (band B) during all three years (2010 to 2012) of this audit period.

Two other SCA sites which were sampled in spring 2012 (MMP130 and MMP226) were assessed as reference condition (band A) and an additional nine sites were sampled by OEH in autumn 2011 of which one site was assessed as reference condition (band A), seven as significantly impaired (band B), including one site with riffle habitat, and one site as severely impaired (band C). Considering all results of sites in the Wollondilly River sub-catchment sampled in this audit period the majority of samples were assessed as significantly impaired (band B).

Comparison of the AUSRIVAS results presented in the previous audit to data provided for the current 2010 to 2012 audit period (Figure I 1-50) shows a considerable decline in condition across the Wollondilly River sub-catchment. A decline in sites rated as reference condition (band A), and a large increase in sites assessed as significantly impaired (band B), suggests condition of sites has declined. However this includes a large number of sites were sampled and assessed by OEH in autumn 2011 for the first time and historical data for these sites was not provided and may not be available. Although the majority of these sites were rated significantly impaired (band B) the condition of these sites may be stable and may not have declined since the previous audit period.

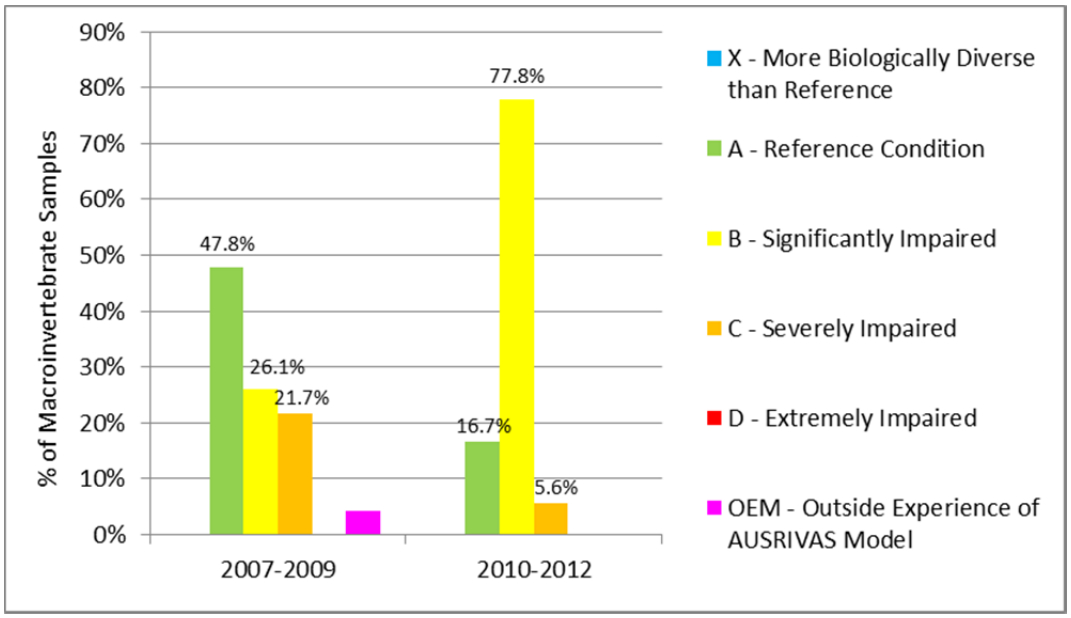
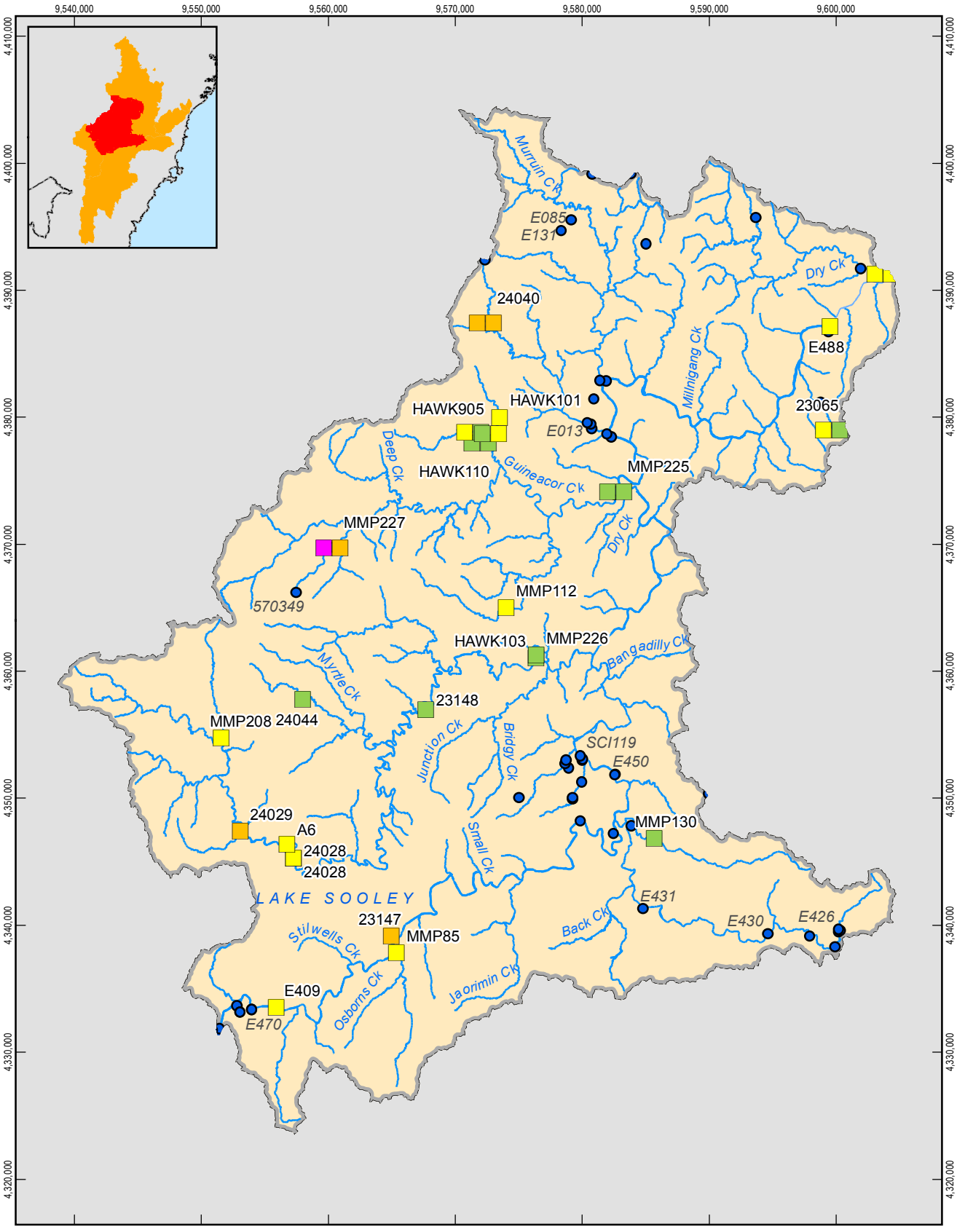


Figure I 1-50 Comparison of AUSRIVAS results from the Wollondilly River sub-catchment: 2007-09 to 2010-12



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model
- *Water Quality Monitoring Site*
- Waterbody
- Waterway
- Sub-catchment Boundary
- Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Sydney Catchment Authority
Catchment Audit 2013

Wollondilly River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number	2314960
Revision	0
Date	26 Nov 2013

Figure I 1-51

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Level 6, 20 Smith Street Parramatta NSW 2150 Australia T 61 2 8898 8800 F 61 2 8898 8810 E ptamail@ghd.com W www.ghd.com

Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

Table I 1-28 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Wollondilly River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
22130	Edge	-34.18774	150.29944										B			
22130	Riffle	-34.18774	150.29944										B			
23065	Edge	-34.29995	150.25951										B			
23065	Riffle	-34.29995	150.25951										A			
23147	Edge	-34.66837	149.89313										C			
23148	Edge	-34.50699	149.91734										A			
24028	Edge	-34.61496	149.8073								A					
24028	Edge	-34.61496	149.8073								B					
24029	Edge	-34.59682	149.76092								C					
24040	Edge	-34.23099	149.96062										C			
24040	Riffle	-34.23099	149.96062										C			
24044	Edge	-34.50198	149.81162										A			
A6	Edge	-34.60536	149.80126		A	A	B	C	OEM	B	A	A	B	B	B	B
E409	Edge	-34.72142	149.79604			B										
E488	Edge	-34.22634	150.25412		fires	A	A	OEM	B	A	A	B	A	B	B	B
HAWK101	Edge	-34.2979	149.9737	B												
HAWK103	Edge	-34.4678	150.0105	A												
HAWK110	Edge	-34.3162	149.9592	A												
HAWK110	Riffle	-34.3162	149.9592	A												
HAWK904	Edge	-34.3092	149.9524	B												
HAWK904	Riffle	-34.3092	149.9524	A												
HAWK905	Edge	-34.3097	149.9676	A												
HAWK905	Riffle	-34.3097	149.9676	B												
MMP112	Edge	-34.43278	149.98376					B								
MMP130	Edge	-34.59348	150.11683						X							A
MMP208	Edge	-34.53104	149.74265							B						
MMP225	Edge	-34.34818	150.07643									A				
MMP225	Riffle	-34.34818	150.07643									A				
MMP226	Edge	-34.46576	150.01074								A					A
MMP227	Edge	-34.3936	149.83444								OEM					
MMP227	Riffle	-34.3936	149.83444								C					
MMP85	Edge	-34.68036	149.89818				B									

Table I 1-28 (cont.) AUSRIVAS ranking of macroinvertebrate monitoring sites in the Wollondilly River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
22134	Edge	-34.2847	150.25004												B	
22159	Edge	-34.18309	150.28058												B	
22159	Riffle	-34.18309	150.28058												B	
23162	Edge	-34.25263	150.22934												C	
23163	Edge	-34.51046	150.05207												A	
23170	Edge	-34.70785	149.88861												B	
23203	Edge	-34.62928	149.97104												B	
24111	Edge	-34.55801	149.73967												B	
24126	Edge	-34.60561	149.80185												B	
24132	Edge	-34.59618	149.76089												B	

Water availability

Surface water flow

Flow data from three gauges within the Wollondilly River sub-catchment was considered under this current audit. The assessment of these gauges is consistent with previous audits. Table I 1-29 identifies the gauges assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-29 Flow (ML/day) at gauging stations in the Wollondilly River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
2122711	Wollondilly River at Murrays Flat	17/08/1990	11.51	5.06	3.24	3.93	20.85
212271	Wollondilly River at Golden Valley	02/01/1974	38.79	13.54	9.15	14.79	61.71
212270	Wollondilly River at Jooriland	15/12/1961	233.91	63.66	290.84	242.67	255.81
212060	Tarlo River at Willowbank	10/02/2011	13.61 [1]	N/A [1]	N/A [1]	N/A [1]	13.60

Note:

1. Monitor 212060 commenced recording on 10/02/2011.

Flows in Wollondilly River at Murrays Flat (monitor 2122711) were approximately double the long-term average (median 20.85 ML/day vs. long-term 11.51 ML/day). This is against the general trend from previous audit periods where the daily average flow rates were well below the long-term average. All audit periods have days of data where no flow was recorded (2001-2004, 2%, 2004-2007, 12%, 2007-2010, 5%, and 2010-2013, 13%).

Flows in Wollondilly River at Golden Valley (monitor 212271) were above the long-term average (median 61.71 ML/day vs. long-term 38.79 ML/day). This goes against the trend of the previous audit periods that were well below the long-term average. For example, the daily average flow for the 2001-2004 audit period was nearly ten times less than the long-term daily average. The dataset for the current audit period has a complete dataset with only 2 days where no flow was recorded. The other audit periods all have sections of days where no flow was recorded.

Flows in Wollondilly River at Jooriland (monitor 212270) were slightly above the long-term average (median 255.81 ML/day vs. long-term 233.91 ML/day). This goes against the general trend of the previous audit periods where the daily average flow was well below the long-term

trend. Consideration of the number of days where no flow was recorded identified that the current audit period only has six days (1%) where no flow was recorded whereas the 2001-2004 (4%) and 2004-2007 (10%) audit periods had a greater number of days.

No definitive correlation could be drawn between the current audit period flows in Tarlo River at Willowbank (monitor 212060) and the long-term flows as the monitor only commenced recording on 10/02/2011. Therefore, no comparison could be done with previous audit periods.

Catchment water quality

Long-term water quality monitoring in the Wollondilly River sub-catchment is undertaken by the SCA at Murrays Flat (E409 – approximately 10 km downstream of Goulburn), Golden Valley (E450 – approximately 50 km downstream of Goulburn) and Jooriland (E488 – near the Wollondilly arm inlet to Lake Burragorang).

E409 - Wollondilly River at Murray's Flat

- The median TN concentration for E409 was 0.620 mg/L during the current audit; all recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was lower than for all previous audits (median values for previous five audits ranged from 0.720 to 1.245 mg/L). A significant long-term trend was detected with concentrations decreasing by 0.019 mg/L per year.
- During the current audit the median TP concentration for E409 was 0.034 mg/L; 77% of recordings above the ANZECC guideline for upland rivers. The median TP concentration during the current audit was noticeably lower than the previous audits (median values for previous five audits ranged from 0.066 to 0.413 mg/L). A significant long-term trend was detected for TP with concentrations decreasing by 0.007 mg/L per year.
- The median electrical conductivity for E409 was 0.728 mS/cm during the current audit; 94% of recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was greater than most other audit periods except for 2001-04 when the median conductivity was 0.963 mS/cm. There was no significant long-term trend detected for conductivity at E409.
- The median chlorophyll à concentration for E409 was 7.0 µg/L during the current audit; 72% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was generally similar to other audits (median values for previous five audits ranged from 4.5 to 8.3 µg/L) although a significant trend was detected with concentrations decreasing by 0.27 µg/L per year.

E450 - Wollondilly River at Golden Valley d/s of Goulburn

- The median TN concentration for E450 was 0.500 mg/L during the current audit; all recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was again lower than for all previous audits (median values for previous five audits ranged from 0.510 to 0.845 mg/L). Despite this, no significant long-term trend in TN was detected.
- The median TP concentration for E450 was 0.014 mg/L during the current audit; 26% of recordings exceeding the ANZECC guideline for upland rivers. Overall, the median TP concentration during the current audit was lower than the previous five audits (median values ranged from 0.015 to 0.04 mg/L) although it was similar to the 2001-04 median concentration (0.015 mg/L). The TP concentrations were found to be increasing at a rate of 0.001 mg/L per year.

- The median conductivity for E450 during the current audit was 0.499 mS/cm; 83% of recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was generally similar to the previous five audits (median values ranged from 0.300 to 0.577 mS/cm) although a significant long-term trend was detected with conductivity decreasing by 0.021 mS/cm per year.
- For E450 the median chlorophyll à concentration during the current audit was 2.8 µg/L; 19% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of concentrations recorded in previous audits (median values for previous five audits ranged from 1.4 to 5.9 µg/L). Despite this, a significant long-term trend was detected with chlorophyll à decreasing by 0.22 µg/L per year.

E488 - Wollondilly River at Jooriland

- For E488 the median TN concentration for the current audit was 0.460 mg/L; the majority of recordings (97%) exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was less than the previous audits (median values for previous five audits ranged from 0.480 to 0.875 mg/L). No significant long-term trend was detected for TN.
- For E488 the median TP concentration was 0.016 mg/L during the current audit; 36% of recordings exceeding the ANZECC guideline for upland rivers. Generally, the median TP concentration during the current audit was similar to or less than previous audits (median values for previous five audits ranged from 0.012 to 0.065 mg/L). A significant long-term trend was detected for TP with increases of 0.001 mg/L per year.
- During the current audit at E488 the median conductivity was 0.360 mS/cm; 50% of recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was higher than or similar to all previous audit periods (median values ranged from 0.172 to 0.345 mS/cm). However, a significant long-term trend was detected with conductivity decreasing by 0.009 mS/cm per year. This decreasing trend was most likely due to the lower conductivities during the 2004-07 and 2007-10 audit periods were median values were 0.172 and 0.194 mS/cm respectively.
- For E488 the median chlorophyll à concentration was 5.2 µg/L for the current audit; half of the recordings (50%) exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of concentrations detected in previous audits (median values for previous five audits ranged from 0.9 to 8.2 µg/L). A significant long-term trend was detected for chlorophyll à with concentrations increasing by 0.52 µg/L per year.

Storage water quality

No long-term water quality monitoring data for storages in the Wollondilly River sub-catchment was made available to the auditor for the 2010-13 audit period.

1.14 Mulwaree River

1.14.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Mulwaree River sub-catchment are shown Figure I 1-52.

Similar to the Upper Wollondilly land use in the Mulwaree River sub-catchment is principally dominated by Production form Dryland Agriculture and Plantations (79.4%) with the vast majority of this being Grazing modified pastures (77.3%). Conservation and Natural Environments (10.5%) contributed a considerable proportion of the land use in the sub-catchment and was also the second most extensive land use in the sub-catchment. This was almost entirely attributed to Other minimal use (10.2%) with little Nature conservation (0.3%). Intensive uses (7.0%) contributed a small portion of the land use across the sub-catchment and this was primarily contributed to Residential and farm infrastructure (3.3%) and Transport and communication (1.4%). Water (2.7%) was also a portion of the land use within the sub-catchment and this was primarily attributed to Lakes (1.6%).

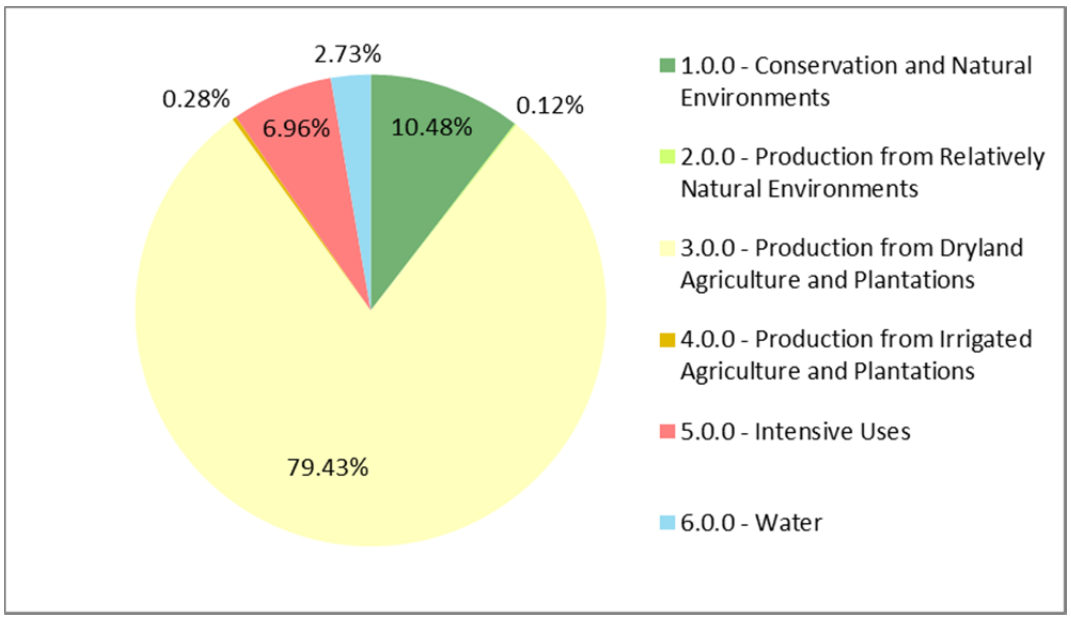


Figure I 1-52 Land use in the Mulwaree River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for Mulwaree River sub-catchment were primarily sourced from the SCA macroinvertebrate monitoring program with data for an additional two sites provided by OEH. The results are summarised in Figure I 1-53, Figure I 1-55 and Table I 1-30.

A total of nine sites have been sampled for macroinvertebrates since 2001 and historic data for an additional site was also available, totalling 10 sites sampled across the Wollondilly River sub-catchment. Riffle habitat was not sampled at any sites suggesting riffle habitats rarely occur in the reaches of the Mulwaree River sub-catchment.

AUSRIVAS analysis results showed the majority of sites samples to be reference condition (band A) (46.7%) followed by significantly impaired (band B) (33.3%), severely impaired (band C) (16.7%) and one site (E457) was assessed as extremely impaired (band D) in spring 2009.

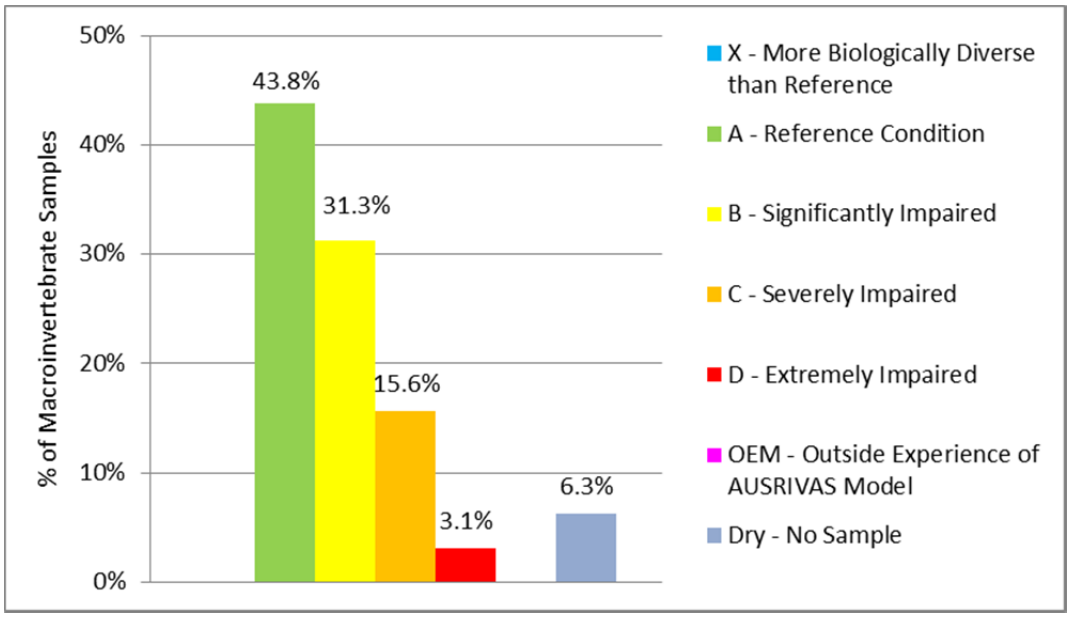


Figure I 1-53 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Mulwaree River sub-catchment

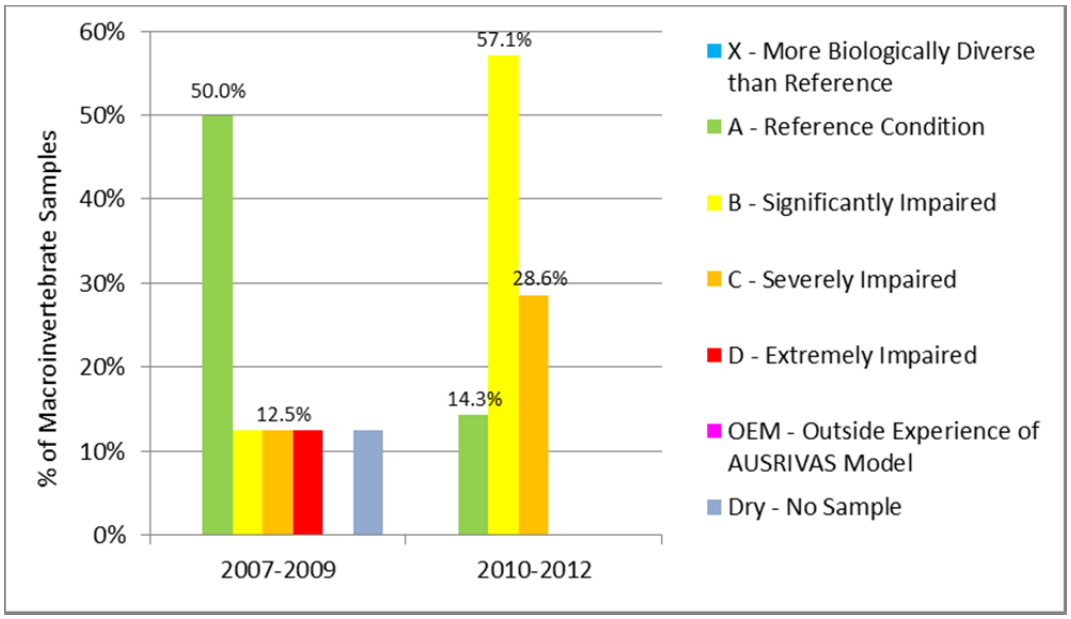


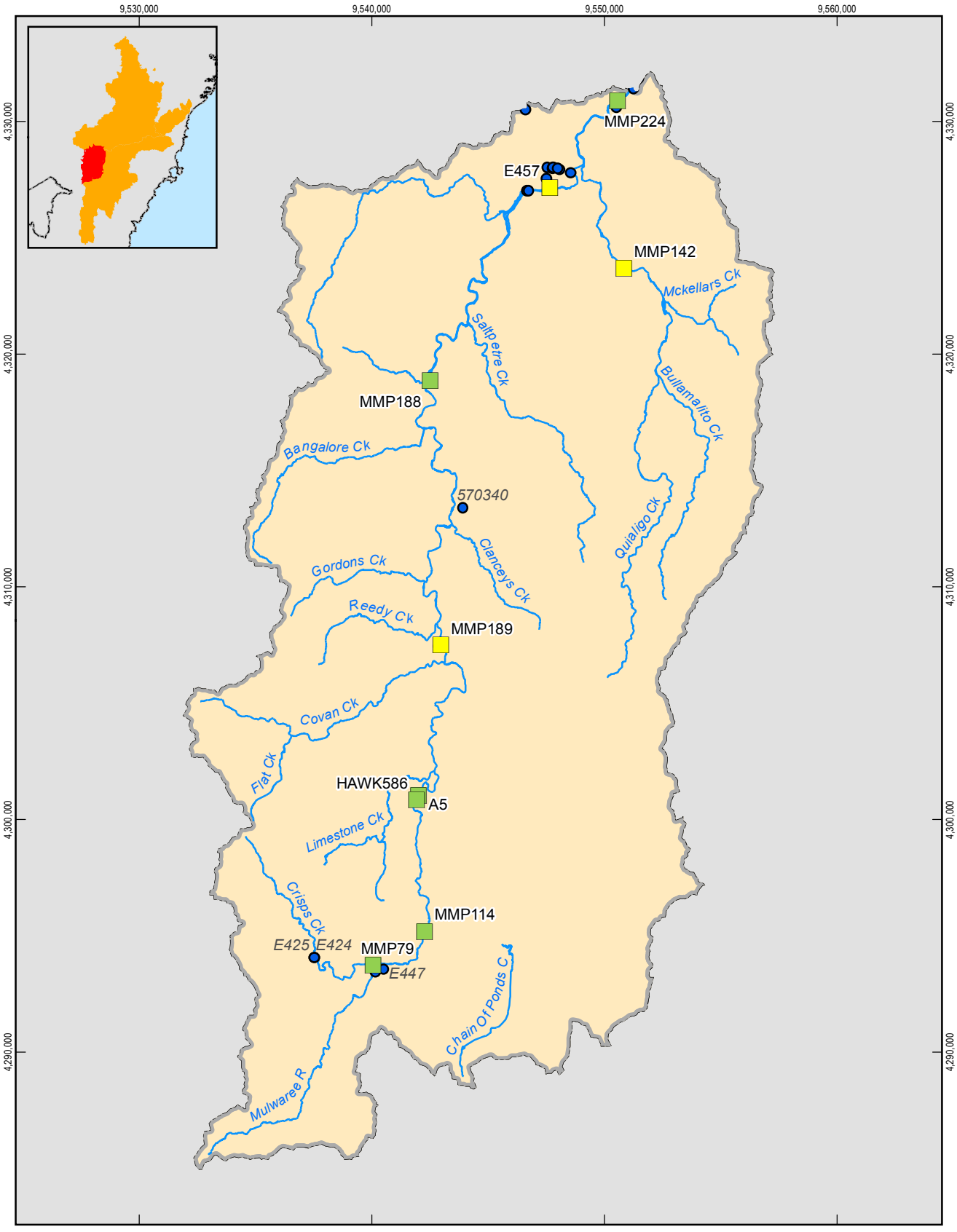
Figure I 1-54 Comparison of AUSRIVAS results from the Mulwaree River sub-catchment: 2007-09 to 2010-12

Two sites (A5 and E457) have been sampled (both edge habitats only) consistently from 2001 as part of the SCA monitoring program and are considered long-term monitoring sites. Both sites showed AUSRIVAS assessments to fluctuate over time however A5 was generally more consistent even though it was dry during two sampling events (2004 and 2009).

The long-term monitoring sites were both sampled consistently during this audit period and both sites have shown an improvement in AUSRIVAS assessment during the most recent sampling event in spring 2012. A5 was assessed as significantly impaired (band B) in 2010 and 2011 but

increased to reference condition (band A) in spring 2012. E457 displayed the same pattern although it was assessed as severely impaired (Band C) in 2010 and 2011 and significantly impaired (band B) in 2012. One additional site (23204) within the Mulwaree River sub-catchment was sampled by OEH in autumn 2011 and this was assessed as significantly impaired (band B).

A comparison of AUSRIVAS results provided for the previous audit period to those provided for the 2010 to 2012 audit period in the Mulwaree River sub-catchment (Figure I 1-54) reveals a considerable decline in condition of macroinvertebrate sampling sites. The majority of sites (50%) were rated as reference condition for the previous audit period but this changed dramatically for the current audit period where the majority of sites (57%) were assessed to be significantly impaired. An increase in the number of samples assessed as severely impaired was also evident. These samples were collected for long-term monitoring sites so are likely to accurately reflect a decline in condition within the sub-catchment.



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model

Water Quality Monitoring Site

Waterbody

Waterway

Sub-catchment Boundary

Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

N

Sydney Catchment Authority
Catchment Audit 2013

Mulwaree River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number 2314960
Revision 0
Date 26 Nov 2013

Figure I 1-55

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Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

Table I 1-30 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Mulwaree River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
A5	Edge	-35.01734	149.65313		A	A	A	dry	B	A	A	A	dry	B	B	A
E457	Edge	-34.78062	149.70775		B	C	A	B	B	C	A	C	D	C	C	B
HAWK586	Edge	-35.0192	149.6523	A												
MMP114	Edge	-35.07008	149.65766					A								
MMP142	Edge	-34.81098	149.74348						B							
MMP188	Edge	-34.8565	149.65378							A						
MMP189	Edge	-34.959	149.66193									B				
MMP224	Edge	-34.7461	149.73836								A					
MMP79	Edge	-35.08361	149.63389				A									
23204	Edge	-34.76901	149.7351												B	

Water availability

Surface water flow

Flow data from one gauge within the Mulwaree River sub-catchment was considered under this current audit. The assessment of this gauge is consistent with previous audits. Table I 1-31 identifies the gauge assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-31 Flow (ML/day) at gauging stations in the Mulwaree River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
2122725	Mulwaree River at The Towers	07/06/1990	0.00	0.00	0.00	0.00	7.22

The Mulwaree River is a chain-of-ponds type river in a relatively low rainfall area, and consequently does not flow for large proportions of the year at The Towers gauge (long-term average 55% of days with no flow). During the audit period, the river did not flow on approximately 31% of days, indicating more flow days than the long-term average. The flow exceedance curve shows that flows were higher than both the long-term average and the previous audit periods for the full flow exceedance spectrum.

Catchment water quality

Long-term water quality monitoring in the Mulwaree River sub-catchment is undertaken by the SCA at Towers Weir (Site E457 – approximately 10 km upstream of the Wollondilly confluence).

- The median TN concentration for E457 was 0.910 mg/L during the current audit; all recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was lower than for all previous audits (median values for previous five audits ranged from 1.355 to 1.710 mg/L). A significant long-term trend was detected with concentrations decreasing by 0.046 mg/L per year.
- During the current audit the median TP concentration for E457 was 0.033 mg/L; 80% of recordings above the ANZECC guideline for upland rivers. The median TP concentration during the current audit was noticeably lower than the previous audits (median values for previous five audits ranged from 0.090 to 0.110 mg/L). A significant long-term trend was detected for TP with concentrations decreasing by 0.003 mg/L per year.
- During the current audit at E457 the median conductivity was 0.871 mS/cm; 94% of recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was higher than all previous audits (median values ranged from 0.300 to 0.778 mS/cm). A significant long-term trend was detected with conductivity increasing by 0.066 mS/cm per year.
- For E457 the median chlorophyll à concentration was 8.3 µg/L for the current audit; 67% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range detected in previous audits (median values for previous five audits ranged from 5.1 to 16.1 µg/L). A

significant long-term trend was detected for chlorophyll à with concentrations decreasing by 0.81 µg/L per year.

Storage water quality

Not available.

1.15 Wingecarribee River

1.15.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Wingecarribee River sub-catchment are shown Figure I 1-56

Similar to the surrounding sub-catchments land use in the Wingecarribee River sub-catchment is principally dominated by Production form Dryland Agriculture and Plantations (52.6%) with the vast majority of this being Grazing modified pastures (49.7%). Conservation and Natural Environments (29.7%) also contributed a considerable proportion of the land use in the sub-catchment and was almost entirely attributed to Other minimal use (24.7%) with some Nature conservation (4.6%). Intensive uses (11.2%) contributed a lesser portion of the land use across the sub-catchment and this was primarily contributed to Residential and farm infrastructure (6.2%), Intensive animal husbandry (1.8%) and Transport and communication (1.5%). Production from Relatively Natural Environments (3.7%) was attributed solely to Production forestry and Water (2.1%) was primarily attributed to Reservoir (1.6%) in the Wingecarribee Reservoir.

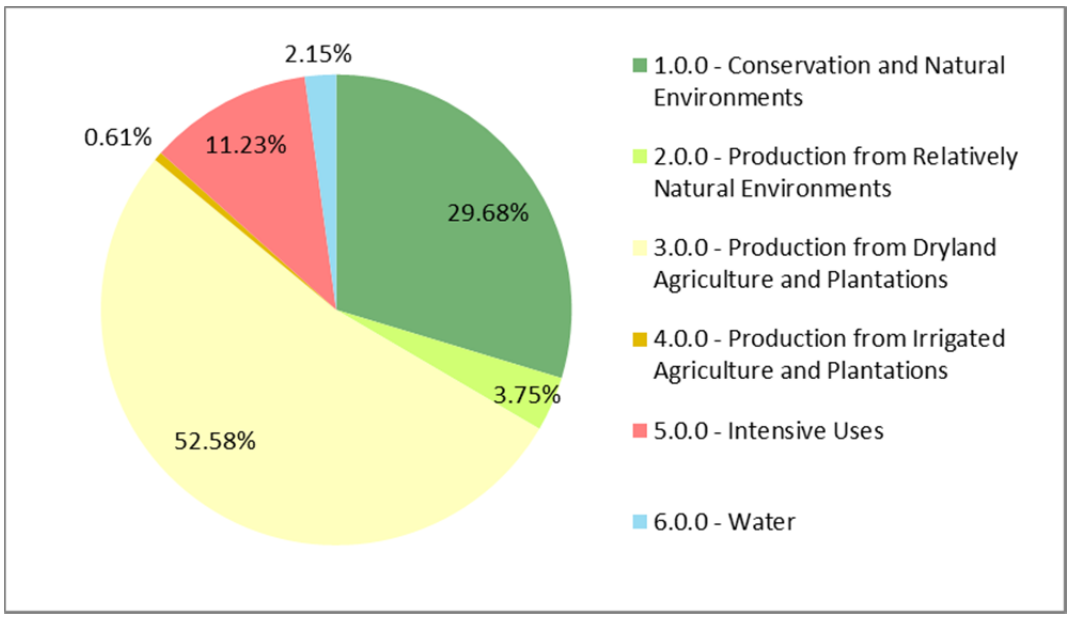


Figure I 1-56 Land use in the Wingecarribee River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for Wingecarribee River sub-catchment were primarily sourced from the SCA macroinvertebrate monitoring program with data for an additional four sites provided by OEH. The results are summarised in Figure I 1-57 and Table I 1-32.

Macroinvertebrate sample data of 14 sites have been provided including nine sites which have been sampled between 2001 and 2012 and three additional sites for which historic data is available. A total of 54 samples have been collected from the Wingecarribee River sub-catchment, the majority of which were edge samples with the exception of the two long-term

SCA monitoring sites, which have both edge and riffle habitats and two historic sites which were riffle only sites.

Results of AUSRIVAS analysis showed the majority of samples to be assessed as reference condition (band A) (48.1%), followed by significantly impaired (band B) (38.9%) and severely impaired (band C) (9.3%). One sample from the edge habitat of the long-term monitoring site (Winge2) was assessed to be more biologically diverse than reference (band X) in 2006 and one historic sample was rated as extremely impaired (band D).

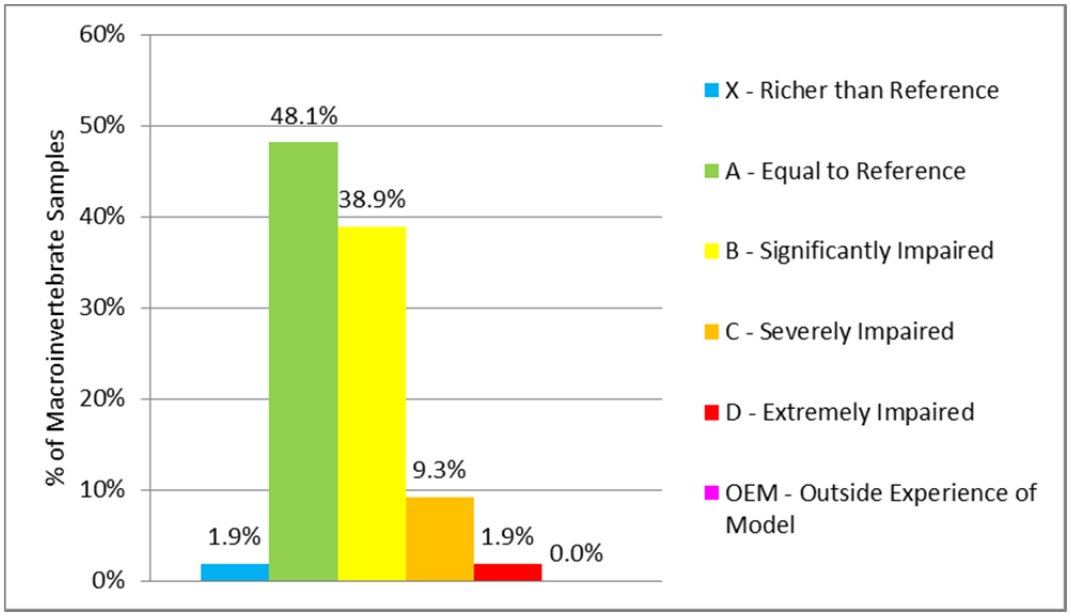


Figure I 1-57 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Wingecarribee River sub-catchment

Of the two long-term monitoring sites (U10 and Winge2) Winge2 consistently scored a higher O/E 50 and was rated as reference condition (band A) for all but three (of a total 21 samples). One edge sample was assessed as more biologically diverse than reference (band X) and two riffle samples (2003 and 2007) were assessed as significantly impaired (band B). All samples collected at Winge2 during this audit period, for both edge and riffle habitats, were rated as reference condition (band A). Macroinvertebrate samples from U10 were generally rated as significantly impaired (band B) including all samples, for both edge and riffle habitats, collected during this audit period.

Comparison of AUSRIVAS sample data provided in the previous audit to the sample results of 2010 to 2012 in the Wingecarribee River sub-catchment (Figure I 1-58) shows a slight improvement in catchment condition, however this only considered data from the two long-term monitoring sites. Both sites have consistently maintained their AUSRIVAS scores since 2008 and the observed change across the catchment is unlikely to represent an actual change in overall catchment condition. Additional monitoring sites within this sub-catchment may provide a clearer understanding of general catchment condition and is also likely to provide further evidence of any temporal changes in condition.

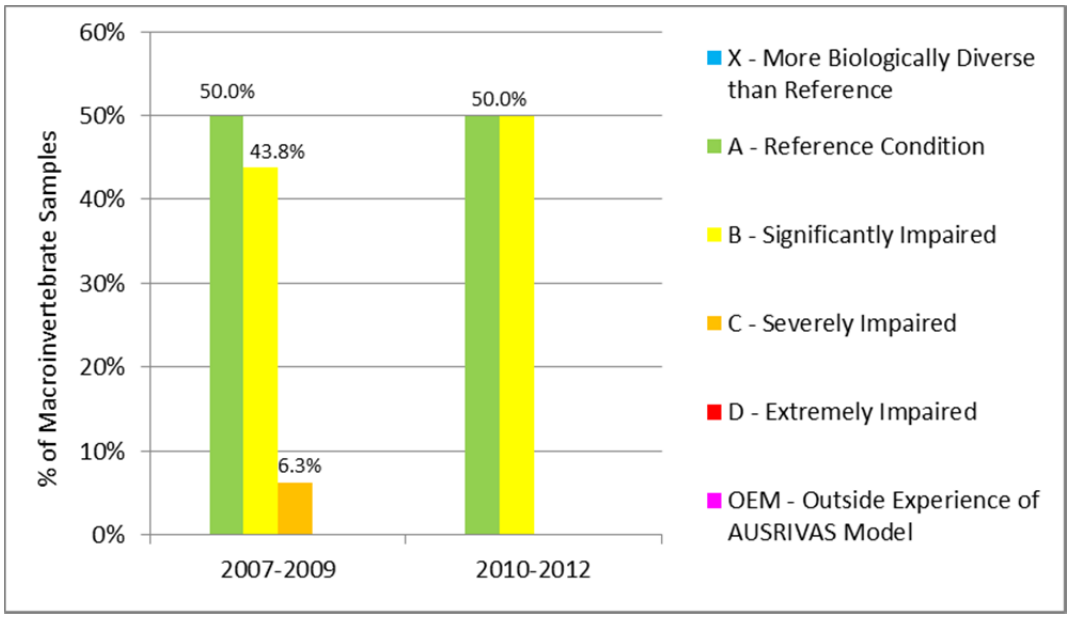
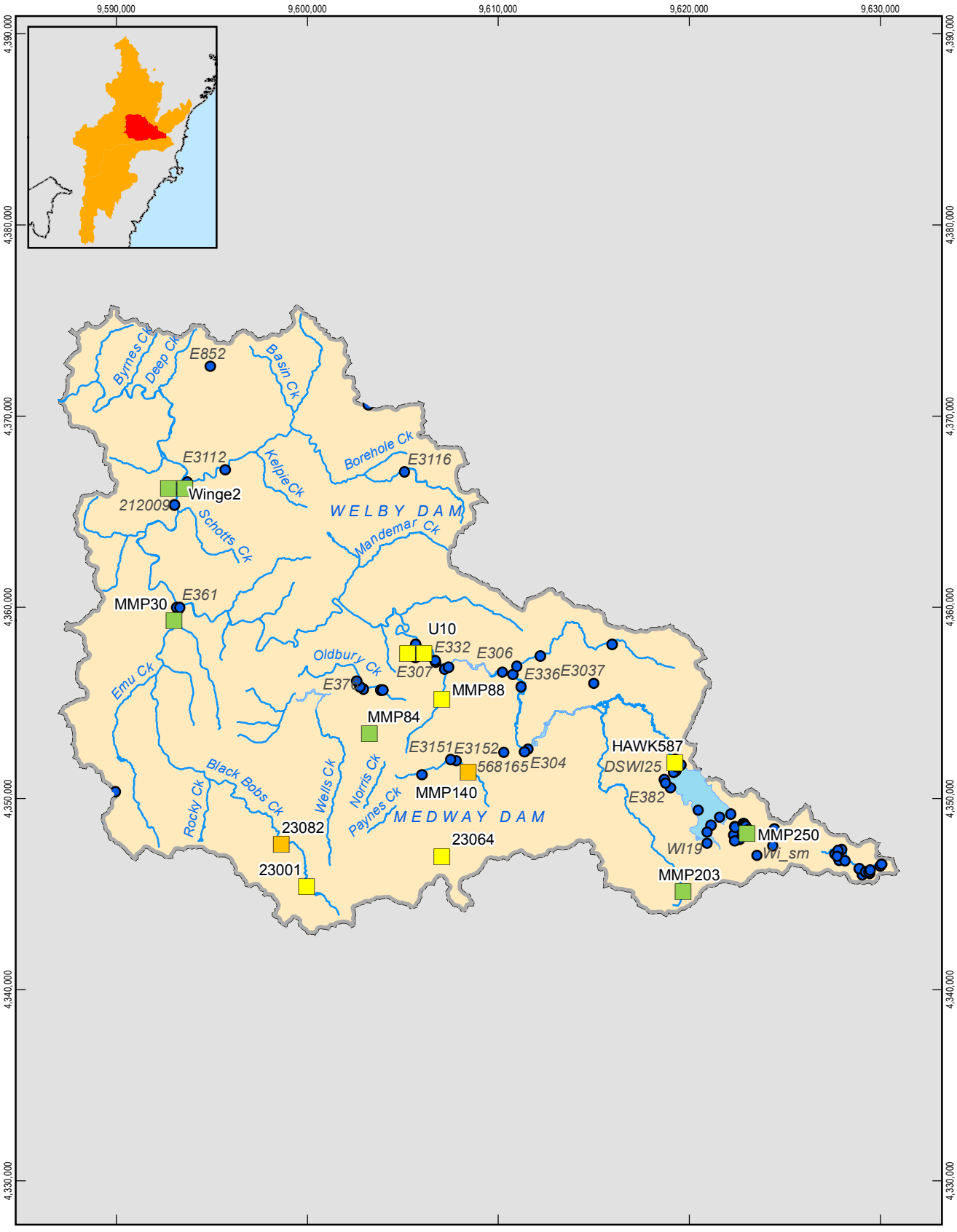


Figure I 1-58 Comparison of AUSRIVAS results from the Wingecarribee River sub-catchment: 2007-09 to 2010-12



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model

Water Quality Monitoring Site

Waterbody

Waterway

Sub-catchment Boundary

Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

N

Sydney Catchment Authority
Catchment Audit 2013

Wingecarribee River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number	2314960
Revision	0
Date	26 Nov 2013

Figure I 1-59

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Level 6, 20 Smith Street Parramatta NSW 2150 Australia T 61 2 8898 8800 F 61 2 8898 8810 E ptamail@ghd.com W www.ghd.com

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Table I 1-32 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Wingecarribee River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
23001	Edge	-34.60276	150.27293								B					
23064	Edge	-34.58644	150.34946										B			
23082	Edge	-34.58324	150.25791										C			
E301	Riffle	-34.579444	150.574167	C												
E302	Riffle	-34.538889	150.482778	D												
HAWK587	Edge	-34.5388	150.4807	B												
MMP140	Edge	-34.54618	150.36319						C							
MMP203	Edge	-34.59932	150.48785							A						
MMP250	Edge	-34.57092	150.5234									A				
MMP30	Edge	-34.47919	150.19288			A										
MMP84	Edge	-34.5296	150.30602				A									
MMP88	Edge	-34.5123	150.34671					dry			B					
U10	Edge	-34.49112	150.33213		B	A	B	B	B	B	A	B	A	B	B	B
U10	Riffle	-34.49112	150.33213				C	B		C		B	B	B	B	B
Winge2	Edge	-34.4167	150.19289		A	A	A	A	A	X	A	A	A	A	A	A
Winge2	Riffle	-34.4167	150.19289				B	A	A	A	B	A	A	A	A	A

Water availability

Surface Water Flow

Flow data from five gauges within the Wingecarribee River sub-catchment was considered under this current audit. The assessment of these gauges is consistent with previous audits. Table I 1-33 identifies the gauge assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-33 Flow (ML/day) at gauging stations in the Wingecarribee River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
212274	Caalang Creek at Maugers	27/11/1986	7.21	4.99	5.50	6.28	10.34
212275	Wingecarribee River at Sheepwash Bridge	09/10/1996	10.37	8.12	202.97	70.38	5.75
212031	Wingecarribee River at Bong Bong Weir	07/06/1989	23.15	18.48	234.27	78.02	23.65
212272	Wingecarribee River at Berrima	22/08/1975	30.64	18.55	223.09	114.54	38.29
212009	Wingecarribee River at Greenstead	26/10/1989	52.00	31.55	225.87	116.98	62.16

Flows in Caalang Creek at Maugers (monitor 212274), for the current audit period, were consistent with the long-term average (median 10.34 ML/day vs. long-term median 7.21 ML/day). The general trend over the previous audit periods was a fairly consistent average daily flow rate below the long-term average.

Flows in Wingecarribee River at Sheepwash Bridge (monitor 212275) were approximately half of the average daily long-term flow rate (median 5.75 ML/day vs long-term 10.37 ML/day). The other audit periods were all above the long-term average daily flow rate. The 2004-2007 average was over five times greater than the current audit period. The data record for this monitor in the current audit period finishes on 31/05/2013.

Flows in Wingecarribee River at Bong Bong Weir (monitor 212031) were slightly below the long-term average (median 23.65 ML/day vs long-term 23.15 ML/day) and shows a general decline in average daily flow from the 2004-2007 audit period. The data record for the current audit period begins on 6/9/2013 and is the continuation of a period of data with no flow recorded that

starts in the previous audit period on 2/06/2010. By comparison the 2004-2007 audit period had a complete dataset with no periods of zero flow recorded. This audit period also had the highest average daily flow rate.

Flows in Wingecarribee River at Berrima (monitor 212272) were slightly higher than the long-term average (median 38.29 ML/day vs. long-term 30.64 ML/day). A general trend showing a decrease in average daily flow rate is present from the 2004-2007 audit period through to the current. The average daily flow rate in the 2001-2004 audit period is below the long-term average.

Flows in Wingecarribee River at Greenstead (monitor 212009) were higher than the long-term average (median 62.16 ML/day vs. long-term 52 ML/day). There is no obvious general trend over the audit periods with all periods since the 2004-2007 audit above the long-term average.

Environmental flows

From the data received and considered as part of this audit it was identified that the Wingecarribee Dam is a structure of importance to environmental flows within the Wingecarribee Sub-catchment.

Table I 1-33 provides a summary of the environmental flows from the Dam for the current audit period and also the previous audit periods for consideration of the long term trends.

Table I 1-34 Summary of environmental flows for the Wingecarribee sub-catchment

Structure	Total Flow (ML)			Median Flow (ML/day)				Average Flow (ML/day)			
	Current Audit Period	07-10 Audit Period	04-07 Audit Period	Current Audit Period	07-10 Audit Period	04-07 Audit Period	Long Term 2004-2013	Current Audit Period	07-10 Audit Period	04-07 Audit Period	Long Term 2004-2013
Wingecarribee Dam	4,384	3,890	2,904	4	4	2	4	4	4	3	3

Catchment water quality

Long-term water quality monitoring in the Wingecarribee River sub-catchment is undertaken by the SCA at the Berrima Weir (Site E332 – downstream of the Wingecarribee Reservoir and the Berrima Sewage Treatment Plant outfall).

- The median TN concentration for E332 was 0.725 mg/L during the current audit; all recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.520 to 1.165 mg/L). Despite this, a significant long-term trend was detected with concentrations decreasing by 0.021 mg/L per year.
- For E332 the median TP concentration was 0.038 mg/L during the current audit; 94% of recordings exceeding the ANZECC guideline for upland rivers. Generally, the median TP concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.036 to 0.060 mg/L). No significant long-term trend was detected for TP.
- The median electrical conductivity for E332 was 0.201 mS/cm during the current audit; 6% of recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was greater than all other audits (median values for previous five audits ranged from 0.104 to 0.167 mS/cm). A significant long-term trend detected for conductivity at E332 with concentrations increasing by 0.002 mS/cm per year.
- For E332 the median chlorophyll à concentration during the current audit was 28.4 µg/L; 97% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was noticeably greater than all previous audits (median values for previous five audits ranged from 9.3 to 19.1 µg/L). A significant long-term trend was detected with chlorophyll à increasing by 0.55 µg/L per year.

Storage water quality

Long-term water quality monitoring in the Wingecarribee River sub-catchment is undertaken by the SCA at the Wingecarribee Lake Outlet (DWI1).

- The median TN concentration for DWI1 was 0.310 mg/L during the current audit; 24% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.300 to 0.610 mg/L). A significant long-term trend was detected with concentrations decreasing by 0.015 mg/L per year.
- For DWI1 the median TP concentration was 0.020 mg/L during the current audit; 90% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.008 to 0.300 mg/L). A significant long-term trend was detected although this was only minor with concentrations increasing by <0.001 mg/L per year.
- The median electrical conductivity for DWI1 was 0.076 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit less than values recorded in previous audits

(median values for previous three audits ranged from 0.079 to 0.089 mS/cm). No significant long-term trend was detected for conductivity at DWI1.

- The median chlorophyll à concentration for DWI1 was 11.7 µg/L during the current audit; 97% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was greater than values recorded in previous audits (median values for previous five audits ranged from 7.2 to 11.0 µg/L). A significant long-term trend was detected with chlorophyll à increasing by 0.3 µg/L per year.

1.16 Woronora River

1.16.1 State of the catchment

Land use and Human settlements

The major ALUM7 land-use classes in the Woronora River sub-catchment are shown in Figure I 1-60.

Conservation and Natural Environments (92.5%) covers the vast majority of the sub-catchment and this is chiefly attributed to Managed resource protection (90.7%) with some Other minimal use (1.6%) and very little Nature conservation (0.16%). Land use of the remainder of the sub-catchment is mostly Water (4.9%), which is predominantly Reservoir (4.8%), and Intensive Uses (1.9%), which is mostly Transport and communications (0.8%). A very small proportion of the Woronora River sub-catchment is used for production with only 0.3% attributed to Production from Dryland Agriculture and Plantations, which is mostly Grazing modified pastures (0.2%), and 0.4% Production from Irrigated Agriculture and Plantations, which is solely attributed to Irrigated perennial horticulture.

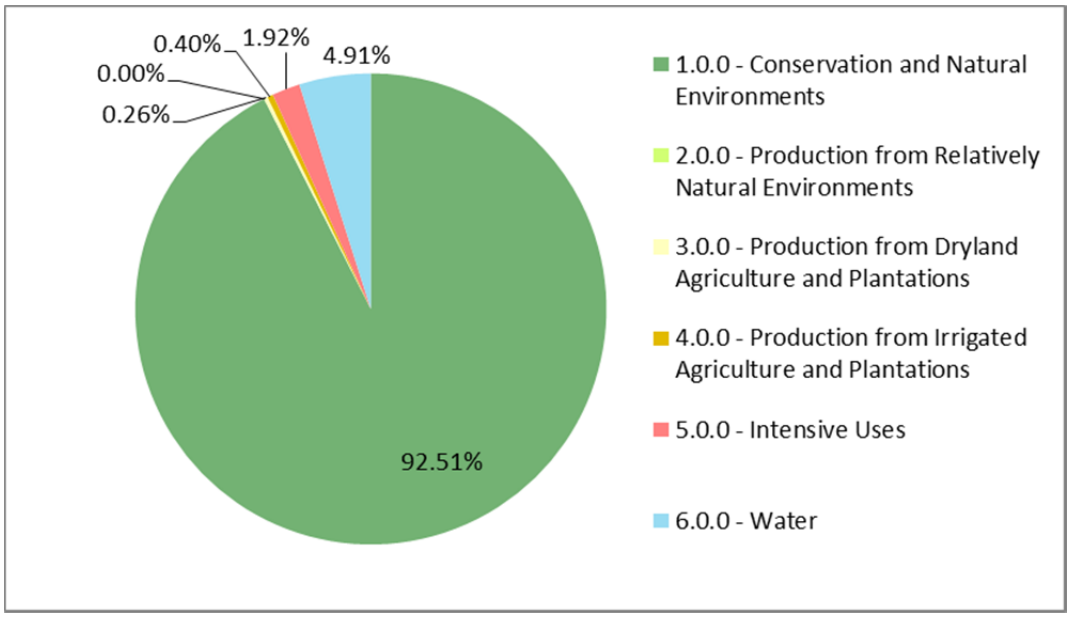


Figure I 1-60 Land use in the Woronora River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for Woronora River sub-catchment were primarily sourced from the SCA macroinvertebrate monitoring programs with data for an additional three sites provided by OEH. The results are summarised in Figure I 1-61 and Table I 1-35.

Macroinvertebrate sample data from the Woronora sub-catchment was available from 14 sites all of which were sampled between 2001 and 2012. No historic data for macroinvertebrates was available. Riffle habitat was sampled from six sites.

Results of AUSRIVAS analysis show the vast majority of Woronora River sites to be assesses as significantly impaired (band B) (56.5%), followed by severely impaired (band C) (21.2%), reference condition (band A) and three samples were rated as more biologically diverse than

reference (band X) (3.5%). One sample could not be collected in 2004 as the site (MMP101) was dry during the scheduled sampling event.

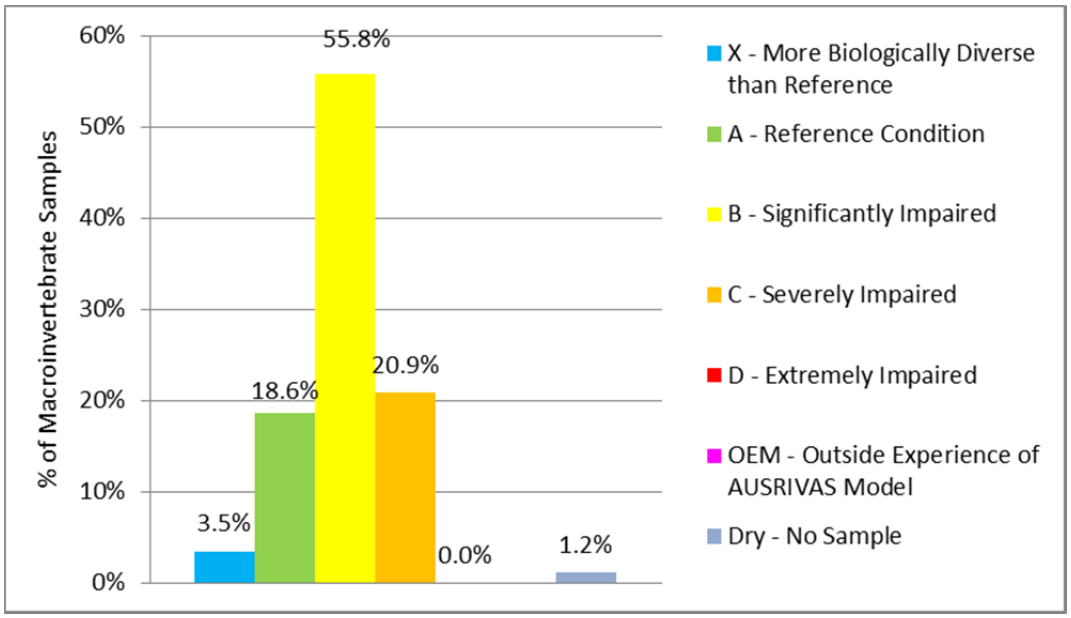


Figure I 1-61 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Woronora River sub-catchment

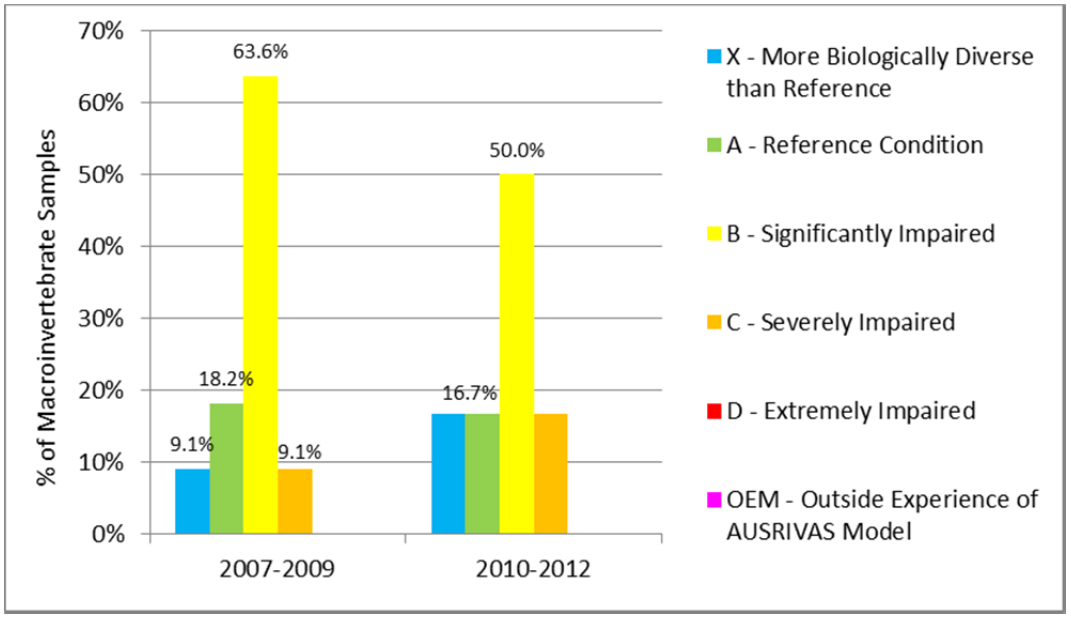


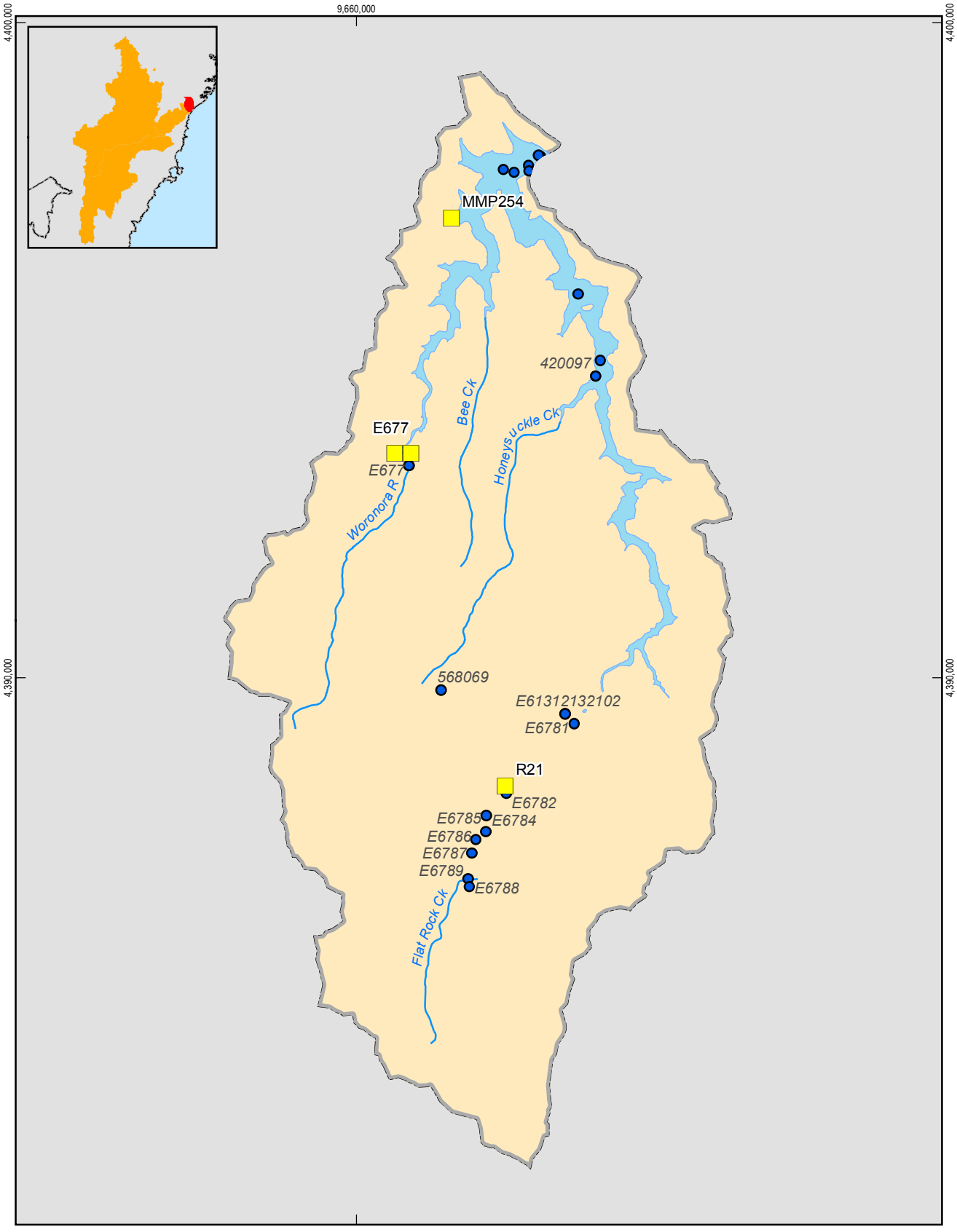
Figure I 1-62 Comparison of AUSRIVAS results from the Woronora River sub-catchment: 2007-09 to 2010-12

G0515 was sampled consistently between 2002 and 2009 and although results fluctuated the majority of samples were rates as significantly impaired (band B). R21 was consistently sampled from 2001 to 2011 and AUSRIVAS results have fluctuated, particularly in the last three years of results which have gone form more biologically diverse than reference (band X) in 2009, decreased to severely impaired (band C) in 2010 then improved to significantly impaired (Band B) for the most recent sample in 2011.

Results of three other sites sampled during this audit period were also available including E677, which both edge and riffle habitats were assessed as significantly impaired (band B) in 2010,

and 23169 and GEORG_WARATAH A which were both edge only sites and were sampled by OEH in autumn 2011. 23169 was assessed to be more biologically diverse than reference (band X) and GEORG_WARATAH A as reference condition (band A).

A comparison of AUSRIVAS results of the current audit period to those provided in the previous audit period (Figure I 1-62) showed little change in condition of macroinvertebrate sampling sites across the Woronora River sub-catchment. The small number of sampling site data provided for both the current audit and the previous audit periods is unlikely to accurately indicate the extent of condition and river health across the sub-catchment. Future audits would benefit from provision of all available data for a more detailed assessment of macroinvertebrate and aquatic ecosystem health within the Woronora River sub-catchment.



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model
- *Water Quality Monitoring Site*
- Waterbody
- Waterway
- Sub-catchment Boundary
- Focus Sub-catchment

Paper Size A4

0 1 2

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Sydney Catchment Authority
Catchment Audit 2013

Woronora River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number	2314960
Revision	0
Date	26 Nov 2013

Figure I 1-63

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Level 6, 20 Smith Street Parramatta NSW 2150 Australia T 61 2 8898 8800 F 61 2 8898 8810 E ptamail@ghd.com W www.ghd.com

Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

Table I 1-35 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Woronora River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
E677	Edge	-34.1507	150.915767									B		B		
E677	Riffle	-34.1507	150.915767				B							B		
GO515	Edge	-34.04656	151.0064		B	B	A	C	C	B	B	C	B			
GO515	Riffle	-34.04656	151.0064				B			B	B	B				
MMP101	Edge	-34.18811	150.89919					dry								
MMP139	Edge	-34.09529	150.97952						B							
MMP209	Edge	-34.06309	150.99651							B						
MMP254	Edge	-34.1181	150.92211									B				
MMP53	Edge	-34.10033	150.9714			A					A					
R21	Edge	-34.19604	150.93453		B	A	B	B	X	A	A	B	X	C	B	
WON01	Edge	-34.10656	150.94793				A									
WON01	Riffle	-34.10656	150.94793			B	A	A	B	B						
WON02	Edge	-34.10033	150.9714			A	A	A	A	B						
WON02	Edge	-34.10033	150.9714			B	B	B	B	B						
WON02	Riffle	-34.10033	150.9714			C										
WON03	Edge	-34.065	150.994			B	B	B	B	B						
WON03	Edge	-34.065	150.994			B	B	B	C	C						
WON03	Riffle	-34.065	150.994				B	B	B	B						
WON03	Riffle	-34.065	150.994			C	C	C	B	B						
WON04	Edge	-34.048063	151.005304			A	A	C	C	B						
WON04	Edge	-34.048063	151.005304			B	B	C	C	C						
WON04	Riffle	-34.048063	151.005304			C	B	C		C						
23169	Edge	-34.19421	150.93642												X	
GEORG_WARATAH A	Edge	-34.20156	150.93136												A	

Water availability

Surface water flow

Flow data from three gauges within the Woronora River sub-catchment was considered under this current audit. The assessment of these gauges is consistent with previous audits. Table I 1-36 identifies the gauge assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-36 Flow (ML/day) at gauging stations in the Woronora River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
2132101	Woronora River Inflow	21/02/2007	2.74 [1]	N/A [1]	N/A [1]	1.32	4.03
2132102	Waratah Rivulet Inflow	21/02/2007	6.57	N/A	10.20	4.83	7.74
213211	Woronora River at The Needles [2]	12/05/1992	17.80	10.79	8.56	16.40	18.55

Note:

1. Monitor 2132101 started recording on 21/02/2007.
2. “The needles" gauge is actually well outside the study area, and represents outflows from Woronora Dam plus downstream runoff.

No definitive correlation could be drawn between the current audit period flows in the Woronora Inflow (monitor 2132101) as the monitor started recording on 21/02/2007. The monitor had large periods of no flow recorded for the current audit period (16% of days) and the dataset finished on 11/03/2013. Large periods of days (46%) with no flow recorded were also identified in the 2007-2010 audit period.

Monitor 2132102 in the Waratah Rivulet Inflow started recording on 21/02/2007. Long-term daily average flows were therefore taken from this date. Flows were above the long-term average (median 7.74 ML/day vs. long-term 6.57 ML/day). Flows in the 2007-2010 audit period were below the long-term average.

Flows in Woronora River at The Needles (monitor 213211) were above the long-term average (median 18.55 ML/day vs. long-term 17.80 ML/day) and showed a general trend of an increase in flows over the audit periods. The previous audit periods were all below the long-term average.

Environmental flows

From the data received and considered as part of this audit it was identified that the Woronora Dam is a structure of importance to environmental flows within the Woronora River Sub-catchment.

Table I 1-37 provides a summary of the environmental flows from the Dam for the current audit period and also the previous audit periods for consideration of the long term trends.

Table I 1-37 Summary of environmental flows for the Woronora River sub-catchment

Structure	Total Flow (ML)			Median Flow (ML/day)				Average Flow (ML/day)			
	Current Audit Period	07-10 Audit Period	04-07 Audit Period	Current Audit Period	07-10 Audit Period	04-07 Audit Period	Long Term 2004-2013	Current Audit Period	07-10 Audit Period	04-07 Audit Period	Long Term 2004-2013
Woronora Dam	24,493	12,886	8,775	7	10	6	8	22	12	8	14

Catchment water quality

The SCA undertakes long-term monitoring in the Woronora River at The Needles downstream of Woronora Reservoir (GO515) and the Waratah River at Flatrock Crossing (E6131). Limited monitoring is also available upstream of the reservoir and includes monitoring at the Woronora River inflow (E677) and Waratah Rivulet (E678). No data for the current audit period was available for E678 or G0515. Furthermore, comparisons to previous audits could not be made for E6131 as no water quality analyses were provided to the auditor.

E677 - Woronora River inflow

- The median TN concentration for E677 was 0.150 mg/L during the current audit; 30% of recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was within the range recorded in previous audits (median values for previous three audits ranged from 0.150 to 0.230 mg/L). No significant long-term trend was detected for TN.
- The median TP concentration for E677 was 0.010 mg/L during the current audit; 7% of recordings exceeded the ANZECC guideline for upland rivers. The median TP concentration during the current audit was again within the range recorded in previous audits (median values for previous three audits ranged from 0.005 to 0.013 mg/L). A significant long-term trend in TP was detected for E677 although the magnitude of change was only minor with concentrations increasing by <0.001 mg/L per year.
- The median electrical conductivity for E677 was 0.180 mS/cm during the current audit; no recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was less than previous audits (median values for previous two audits ranged from 0.143 to 0.219 mS/cm). A significant long-term trend was detected with concentrations decreasing by 0.005 mS/cm per year.
- At E677 the median chlorophyll à concentration was 0.1 µg/L during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was generally similar to other audits (median values for previous three audits ranged from 0.1 to 2.4 µg/L). A significant long-term trend was detected although this was only minor with concentrations increasing by <0.010 µg/L per year.

E6131 - Waratah River at Flatrock Crossing

- The median TN concentration for E6131 was 0.210 mg/L during the current audit; 38% of recordings exceeded the ANZECC guideline for upland rivers. No significant long-term trend was detected for TN.
- For E6131 median TP concentration was 0.012 mg/L during the current audit; 21% of recordings exceeded the ANZECC guideline for upland rivers. A significant long-term trend in TP was detected for E677 although the magnitude of change was only minor with concentrations increasing by 0.001 mg/L per year.
- The median electrical conductivity during the current audit for E6131 was 0.180 mS/cm; no recordings exceeding the ANZECC guideline for upland rivers. A significant long-term trend detected with concentrations decreasing by 0.013 mS/cm per year.
- For E6131 the median chlorophyll à concentration was 0.30 µg/L during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. A

significant long-term trend was detected although this was only minor with concentrations increasing by <0.010 µg/L per year.

Storage water quality

Long-term water quality monitoring in the Woronora River sub-catchment is undertaken by the SCA at the Lake Woronora Dam Wall (DWO1). In previous audits limited data has also been available for the Waratah Rivulet in the vicinity of Flatrock Crossing. However, no data was available at this site for the current audit.

- The median TN concentration for DWO1 was 0.200 mg/L during the current audit; 1% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.190 to 0.230 mg/L). Although a significant long-term trend was detected this was only minor with concentrations decreasing by 0.001 mg/L per year.
- The median TP concentration for DWO1 was 0.006 mg/L during the current audit; 19% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was slightly greater than previous audits (median values for five previous five audits ranged from 0.003 to 0.006 mg/L). A significant long-term trend was detected although this was only minor with concentrations increasing by <0.001 mg/L per year.
- For DWO1 the median electrical conductivity was 0.126 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was higher than previous audits (median values for previous four audits ranged from 0.085 to 0.111 mS/cm). A significant long-term trend was detected with conductivity increasing by 0.002 mS/cm per year.
- The median chlorophyll à concentration for DWO1 was 0.8 µg/L during the current audit; 1% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.8 to 1.5 µg/L). No significant long-term trend was detected with chlorophyll à at DWO1.

1.17 Kangaroo River

1.17.1 State of the catchment

Land use and Human settlements

The major ALUM7 land-use classes in the Kangaroo River sub-catchment are shown in Figure I 1-64.

The main land use in the sub-catchment is attributed to Conservation and Natural Environments (58.4%) which is comprised of the tertiary land use classes of Nature conservation (36.5%) and Other minimal use (21.0%) with little Managed resources protection (1.0%). Production from Dryland Agriculture and Plantations (28.5%) was the second most extensive land use within the sub-catchment and this was primarily attributed to Grazing modified pastures (21.9%) with some Native/exotic pasture mosaic (3.4%) and Plantation forestry (2.5%). Production forestry (8.1%) also contributed a considerable proportion of the sub-catchment land use, while Intensives Uses (2.6%) and Water (2.1%) covered only small portions of the catchment.

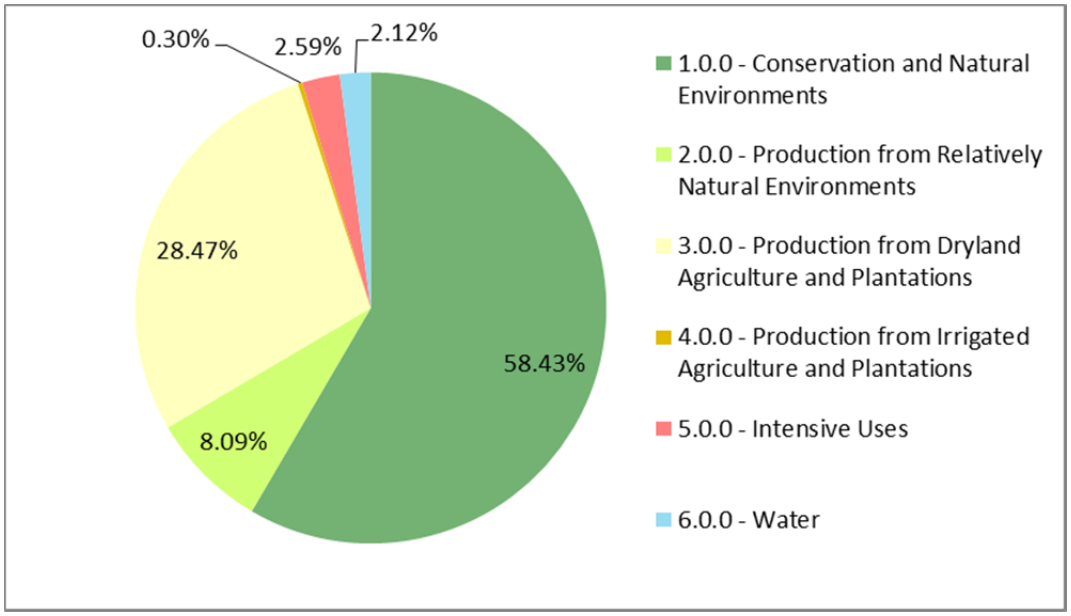


Figure I 1-64 Land use in the Kangaroo River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Kangaroo River sub-catchment were primarily sourced from the SCA macroinvertebrate monitoring program with additional data provided by OEH. The results are summarised in Figure I 1-65, Figure I 1-67 and Table I 1-38.

Data on macroinvertebrates in the Kangaroo River sub-catchment was available from 13 sites which have been sampled on at least one occasion since 2001 and an additional two sites for which historic data was available. Ten of the sample sites had both edge and riffle habitat data available suggesting that riffle habitat is common in the Kangaroo River sub-catchment.

Considering all data available a total of 70 samples have been collected. The results of AUSRIVAS assessment shows the majority of these samples were reference condition (band A) (58.6%), followed by significantly impaired (band B) (20%). Sites that were rated as more

biologically diverse than reference (band X) and severely impaired (band C) each contributed 8.6% of the sites sampled.

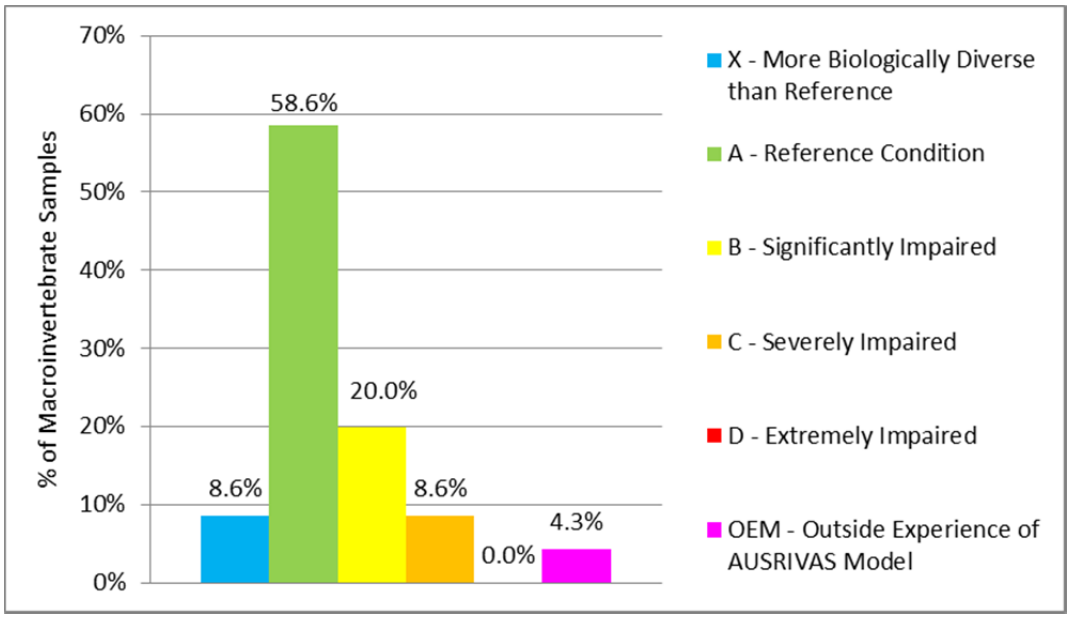


Figure I 1-65 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Kangaroo River sub-catchment

Two core sites, including E706 and MMP43 have been consistently sampled and assessed since 2001 and both have edge and riffle habitats. AUSRIVAS scores at E706 have generally fluctuated between reference condition (band A) and more biologically diverse than reference (band X), however this site has seen a steep decline in AUSRIVAS rating since 2009. Both samples (edge and riffle) collected at this site were rated as severely impaired (band C) in 2010 but improved to significantly impaired (band B) in 2011. The most recent samples collected form E706 were outside the experience of the AUSRIVAS model.

Similar to E706 although slightly lower, AUSRIVAS scores at MMP43 have generally fluctuated between significantly impaired (band B) and reference condition (band A). However, like E706, this site also observed a steep decline in AUSRIVAS rating of the 2010 samples for both habitats, from reference condition (band A) in 2009, to severely impaired (band C) in 2010. The site then increased to reference condition (band A) in 2010 but then again steeply declined with the latest AUSRIVAS rating at MMP43 of severely impaired (band C).

These two long-term monitoring sites within the Kangaroo River sub-catchment were the only sites for which data was provided for the current audit period and as such may not provide a clear indication of temporal changes in catchment wide condition. Comparison of the AUSRIVAS results for the previous audit period to those of the current period (Figure I 1-66) reflects the decline observed a the two long-term monitoring sites. As both habitats at both sites displayed consistent fluctuations the results suggest a considerable impact may have occurred in 2010. Analysis of discharge data within the Kangaroo River sub-catchment shows considerable increase in median flows for the current audit period (Table I 1-39). This may be a key factor influencing macroinvertebrate community stability, and is likely to be a causal factor of the fluctuations in AUSRIVAS ratings observed at the monitoring sites.

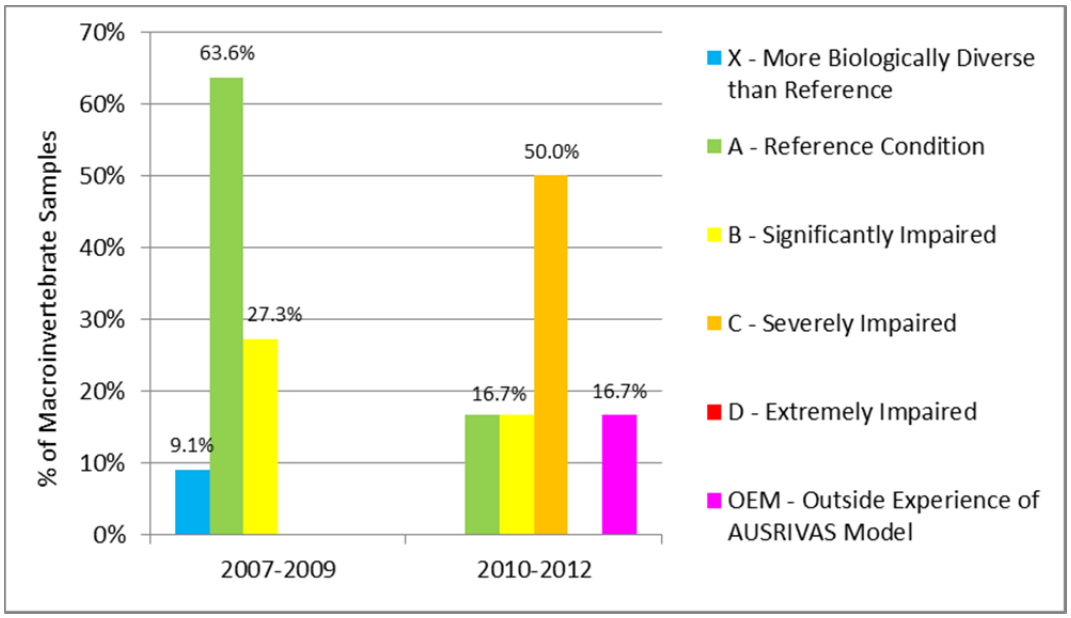
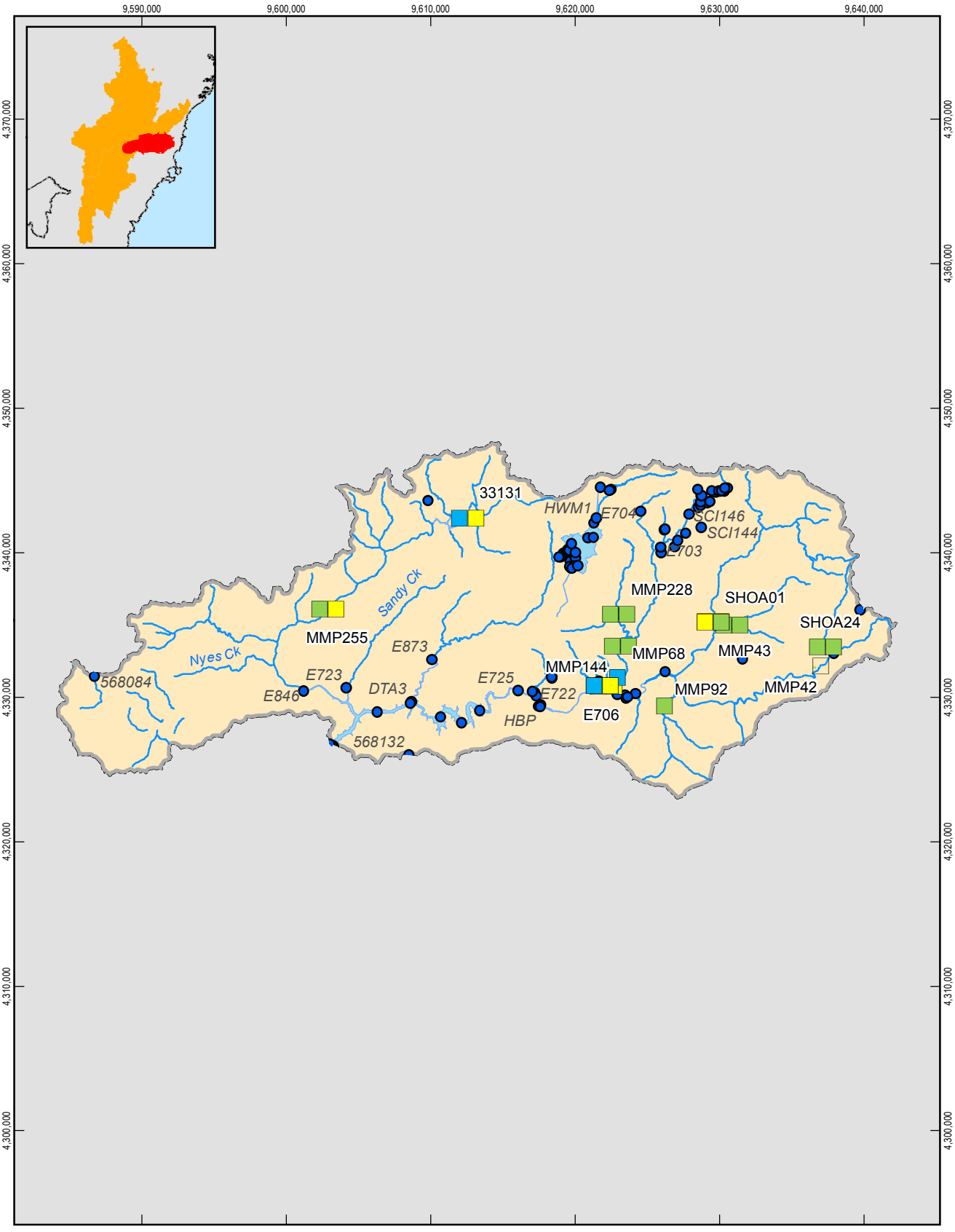


Figure I 1-66 Comparison of AUSRIVAS results from the Kangaroo River sub-catchment: 2007-09 to 2010-12



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model
- *Water Quality Monitoring Site*
- Waterbody
- Waterway
- Sub-catchment Boundary
- Focus Sub-catchment

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Kangaroo River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number 2314960
Revision 0
Date 26 Nov 2013

Figure I 1-67

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Level 6, 20 Smith Street Parramatta NSW 2150 Australia T 61 2 8898 8800 F 61 2 8898 8810 E ptamail@ghd.com W www.ghd.com

Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

Table I 1-38 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Kangaroo River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
33131	Edge	-34.62618	150.41254										X			
33131	Riffle	-34.62618	150.41254										B			
E706	Edge	-34.728	150.52136		OEM	A	A	A	A	X	X	A	A	C	B	OEM
E706	Riffle	-34.728	150.52136				A	A	A	X	A	A	A	C	B	OEM
MMP144	Edge	-34.72236	150.52879						X							
MMP180	Edge	-34.68746	150.61499							A						
MMP180	Riffle	-34.68746	150.61499							A						
MMP228	Edge	-34.68299	150.52925								A					
MMP228	Riffle	-34.68299	150.52925								A					
MMP255	Edge	-34.6854	150.30915									A				
MMP255	Riffle	-34.6854	150.30915									B				
MMP42	Edge	-34.71099	150.68207			A										
MMP43	Edge	-34.68553	150.60091		B	A	B	A	B	B	B	B	A	C	A	C
MMP43	Riffle	-34.68553	150.60091				A	A	A	A	A	B	A	C	A	C
MMP68	Edge	-34.70278	150.53139				A									
MMP68	Riffle	-34.70278	150.53139				A									
MMP92	Edge	-34.73914	150.56512					A								
SHOA01	Edge	-34.68586	150.60075	B						A	A		B			
SHOA01	Riffle	-34.68586	150.60075	A						A	A		A			
SHOA24	Edge	-34.6989	150.6865	A												
SHOA24	Riffle	-34.6989	150.6865	A												
SHOA503	Edge	-34.728	150.5186	A												
SHOA503	Edge	-34.728	150.5186	X												
SHOA503	Riffle	-34.728	150.5186	B												

Water availability

Surface water flows

Flow data from four gauges within the Kangaroo River sub-catchment was considered under this current audit. The assessment of these gauges is consistent with previous audits. Table I 1-39 identifies the gauge assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-39 Flow (ML/day) at gauging stations in the Kangaroo River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
215233	Yarrunga Creek at Wildes Meadow	15/11/1973	6.65	4.16	3.75	6.10	9.47
215234	Yarrunga Creek at Fitzroy Falls	02/03/1983	13.00	8.50	7.86	13.87	17.76
215220	Kangaroo River at Hampden Creek	07/11/1973	167.75	100.18	98.01	152.77	201.55
215215	Shoalhaven River downstream of Tallowa Dam	20/07/1991	358.95	223.32	155.81	167.77	639.84

Flows in Yarrunga Creek at both Wildes Meadow (monitor 215233) and Fitzroy Falls (215234) were slightly higher than both the long-term average and the previous audit period over the full flow exceedance curve (median flows 9.5 ML/day and 17.8 ML/day vs long-term median flows of 6.6 ML/day and 13.0 ML/day respectively).

Flows in the Kangaroo River at Hampden Bridge (monitor 215220) during the audit period (median 201 ML/day) were higher than both the previous audit period (median 152 ML/day) and the long-term median (167 ML/day). This trend was reversed at the high-flow end of the flow-exceedance spectrum, with the 10% exceedance flow in the audit period of 760 ML/day compared to the long-term average of 965 ML/day.

Flows in the Shoalhaven River immediately downstream of Tallowa Dam (monitor 215215) (median 638 ML/day) were significantly higher than the long-term median (358 ML/day). All previous audit period flows (back to 2001) were lower than the long-term median, so this represents a big turn-around attributable to higher rainfalls in the upstream catchments leading

to higher dam releases. The lowest flow recorded in the current audit period was 48 ML/day, compared to between 10 - 15 ML/day in the previous audit periods.

Environmental flows

From the data received and considered as part of this audit it was identified that the Tallowa Dam and Fitzroy Falls Reservoirs are structures of importance to environmental flows within the Kangaroo River Sub-catchment.

Table I 1-40 provides a summary of the environmental flows from the Dam and Reservoir for the current audit period and also the previous audit periods for consideration of the long term trends.

Table I 1-40 Summary of environmental flows for the Kangaroo River sub-catchment

Structure	Total Flow (ML)			Median Flow (ML/day)				Average Flow (ML/day)			
	Current Audit Period	07-10 Audit Period	04-07 Audit Period	Current Audit Period	07-10 Audit Period	04-07 Audit Period	Long Term 2004-2013	Current Audit Period	07-10 Audit Period	04-07 Audit Period	Long Term 2004-2013
Tallowa Dam	834,354	165,249	91,525	388	90	90	90	761	151	84	332
Fitzroy Falls	38,228	18,357	19,505	18	13	9	14	35	17	18	23

Catchment water quality

Long-term water quality monitoring in the Kangaroo River sub-catchment is available from the SCA's monitoring site on the Kangaroo River at Hampden Bridge (site E706).

- The median TN concentration for E706 was 0.420 mg/L during the current audit; 91% of recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.375 to 0.575 mg/L). No significant long-term trend was detected for TN at E706.
- During the current audit the median TP concentration for E706 was 0.035 mg/L; 88% of recordings above the ANZECC guideline for upland rivers. The median TP concentration during the current audit was similar to previous audits (median values for previous five audits ranged from 0.020 to 0.052 mg/L). A significant long-term trend was detected for TP with concentrations increasing by 0.001 mg/L per year.
- The median electrical conductivity for E706 was 0.097 mS/cm during the current audit; no recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was marginally greater than previous audits (median values for previous five audits ranged from 0.075 to 0.088 mS/cm). There was a significant long-term trend detected with conductivity at E706 increasing by 0.001 mS/cm per year.
- The median chlorophyll à concentration for E706 was 2.4 µg/L during the current audit; 16% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was higher than other audits (median values for previous five audits ranged from 0.5 to 2.2 µg/L). A significant long-term trend was detected with concentrations increasing by 0.10 µg/L per year.

Storage water quality

Long-term water quality monitoring in the Kangaroo River sub-catchment is undertaken by the SCA at several storage sites: the Fitzroy Falls Reservoir (DFF6), the Bendeela Pondage (DTA3, DTA8 and DTA10) and the inflow to the Kangaroo River Water Filtration Plant (DBP1 and DKV1). While data was available for the current audit period, only limited historical data is available for comparisons for DBP1. No data was made available for the current audit period for the Bendeela Pondage, DTA10 or DKV1.

DFF6 - Fitzroy Falls Reservoir

- For DFF6 the median TN concentration during the current audit was 0.310 mg/L; 28% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.300 to 0.520 mg/L). A significant long-term trend was detected with concentrations decreasing by 0.009 mg/L per year.
- For DFF6 the median TP concentration during the current audit was 0.013 mg/L; 74% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.005 to 0.019 mg/L). No significant long-term trend was detected for TP at DFF6.
- The median electrical conductivity for DFF6 was 0.078 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The

median conductivity during the current audit was within the range of values from previous audits (median value for previous four audits ranged from 0.069 to 0.093 mS/cm). A significant long-term trend was detected with conductivity increasing at 0.002 mS/cm per year.

- For DFF6 the median chlorophyll à concentration was 13.2 µg/L during the current audit; 98% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values recorded for previous audits (median values for five previous audits ranged from 4.3 to 13.5 µg/L). A significant long-term trend was detected for chlorophyll à with concentrations increasing by 0.56 µg/L per year.

DTA3 - Bendeela Pondage

- For DTA3 the median TN concentration during the current audit was 0.370 mg/L; 64% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.300 to 0.400 mg/L). A significant long-term trend was detected with concentrations decreasing by 0.010 mg/L per year.
- For DTA3 the median TP concentration during the current audit was 0.018 mg/L; 79% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was greater than values recorded in previous audits (median values for previous five audits ranged from 0.005 to 0.013 mg/L). Despite this, a significant long-term trend was detected for TP with concentrations decreasing by 0.001 mg/L per year.
- The median electrical conductivity for DTA3 was 0.092 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was within the range of values recorded in previous audits (median value for previous four audits ranged from 0.077 to 0.101 mS/cm). A significant long-term trend was detected with conductivity increasing at 0.001 mS/cm per year.
- During the current audit the median chlorophyll à concentration was 5.4 µg/L for DTA3; 56% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values recorded for previous audits (median values for five previous audits ranged from 4.5 to 5.7 µg/L). No significant long-term trend was detected for chlorophyll à at DTA3.

DTA8 - Bendeela Pondage

- The median TN concentration for DTA8 was 0.370 mg/L during the current audit; 58% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was within the range of values recorded in previous audits (median values for five previous audits ranged from 0.300 to 0.400 mg/L). No significant long-term trend was detected for TN at DTA8.
- The median TP concentration for DTA8 was 0.031 mg/L during the current audit; 100% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was greater than for previous audits (median values for four previous audits ranged from 0.013 to 0.020 mg/L) although no significant long-term trend was detected.

- For DTA8 the median electrical conductivity during the current audit was 0.099 mS/cm; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was within the range of values recorded for previous audits (median value for previous four audits ranged from 0.078 to 0.099 mS/cm). No significant long-term trend was detected for conductivity at DTA8.
- For DTA8 the median chlorophyll à concentration was 5.0 µg/L during the current audit; 50% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was lower than previous audits (median values for five previous audits ranged from 6.2 to 11.8 µg/L). Despite this a significant long-term trend was detected for chlorophyll à with concentrations increasing by 1.48 µg/L per year.

DBP1 - Inflow to the Kangaroo River Water Filtration Plant

- The median TN concentration for DBP1 was 0.320 mg/L during the current audit; 33% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs (although this was limited to only 3 recordings). The median TN concentration during the current audit was lower than the 2001-04 audit for which data was available (median value 0.370 mg/L). An assessment of long-term trends could not be made for TN at DBP1 due to limited data.
- For DBP1 the median TP concentration was 0.031 mg/L during the current audit; all recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was higher than the 2001-04 audit for which data was available (median value 0.019 mg/L). No long-term trend analyses could be carried out for TP at DBP1 due to limited data.
- The median electrical conductivity for DBP1 was 0.094 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was within the range of values from previous audits (median value for 1998-2001 was 0.058 mS/cm and for 2004-07 was 0.100 mS/cm). No significant long-term trend was detected with conductivity at DBP1.
- The median chlorophyll à concentration for DBP1 was 14.6 µg/L during the current audit; 87% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. There was no data from previous audits to make comparisons with. No significant long-term trends were detected for chlorophyll à at DBP1.

1.18 Nerrimunga Creek

1.18.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Nerrimunga Creek sub-catchment are shown in Figure I 1-68.

Analysis of land use in the Nerrimunga Creek sub-catchment shows just under half of the catchment is used for Production from Dryland Agriculture and Plantations (47.9%) and this is chiefly attributed to Grazing modified pastures (42.3%) with some Plantation forestry (3.7%) and Land in transition (1.8%). Conservation and Natural Environments (29%) is the second most extensive land use in the sub-catchment but this is primarily the tertiary class of Other minimal use (21.4%) with some Nature conservation (7.6%). Intensive Uses (21.7%) is also extensively spread across the sub-catchment with Residential and farm infrastructure (20.6%) the key tertiary class. Water (1.7%) also contributes to a small proportion of the sub-catchment, most of which is Reservoir (0.6%).

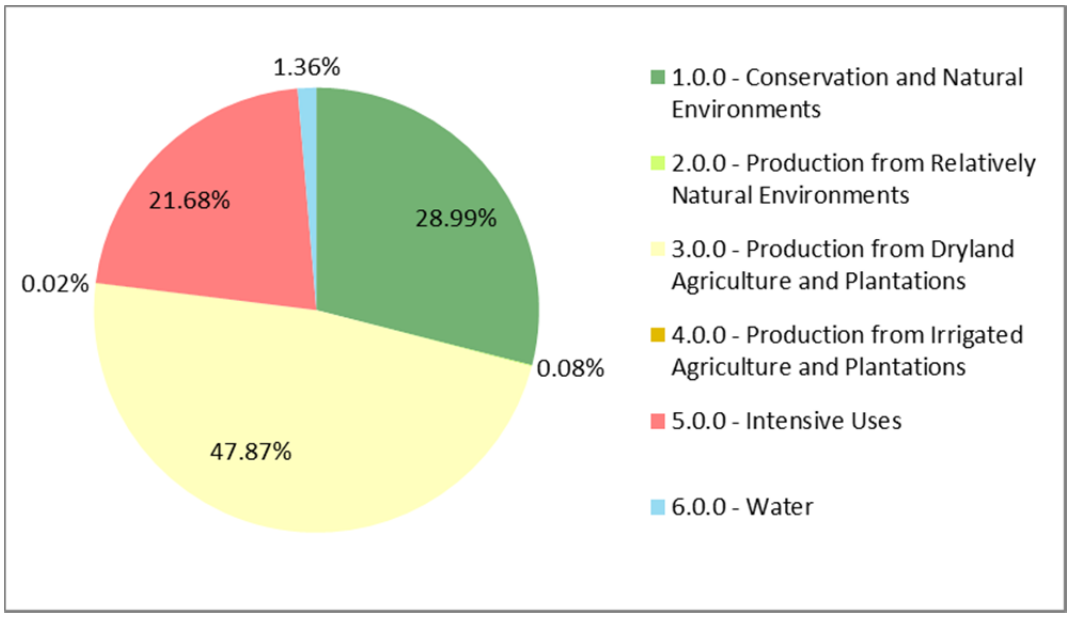


Figure I 1-68 Land use in the Nerrimunga Creek sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Nerrimunga Creek sub-catchment were primarily sourced from the SCA macroinvertebrate monitoring program with additional data provided by OEH. The results are summarised in Figure I 1-69, Figure I 1-71 and Table I 1-41.

Data on macroinvertebrates in the Nerrimunga Creek sub-catchment were available from 12 sites and data for a total of 36 samples was provided, all of which were form edge habitats, which suggests that riffle habitats are generally not present within the sub-catchment.

The majority of samples were rated as significantly impaired (band B) (55.6%), followed by reference condition (band A) (30.6%), and severely impaired (band C) (11.1%) which suggests sites within the Nerrimunga sub-catchment are generally degraded to some extent.

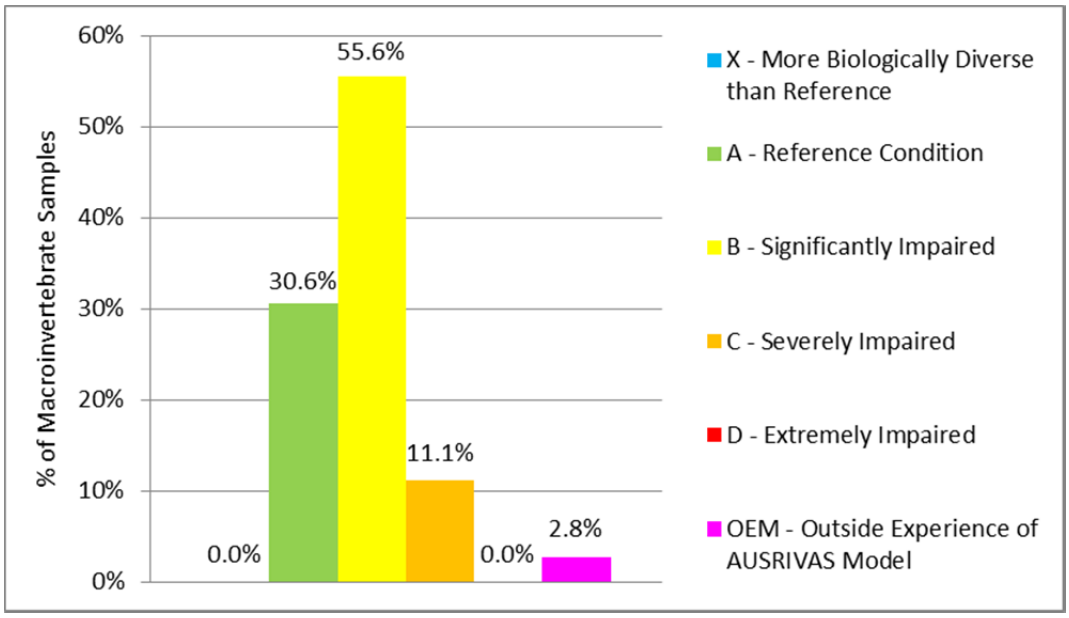


Figure I 1-69 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Nerrimunga Creek sub-catchment

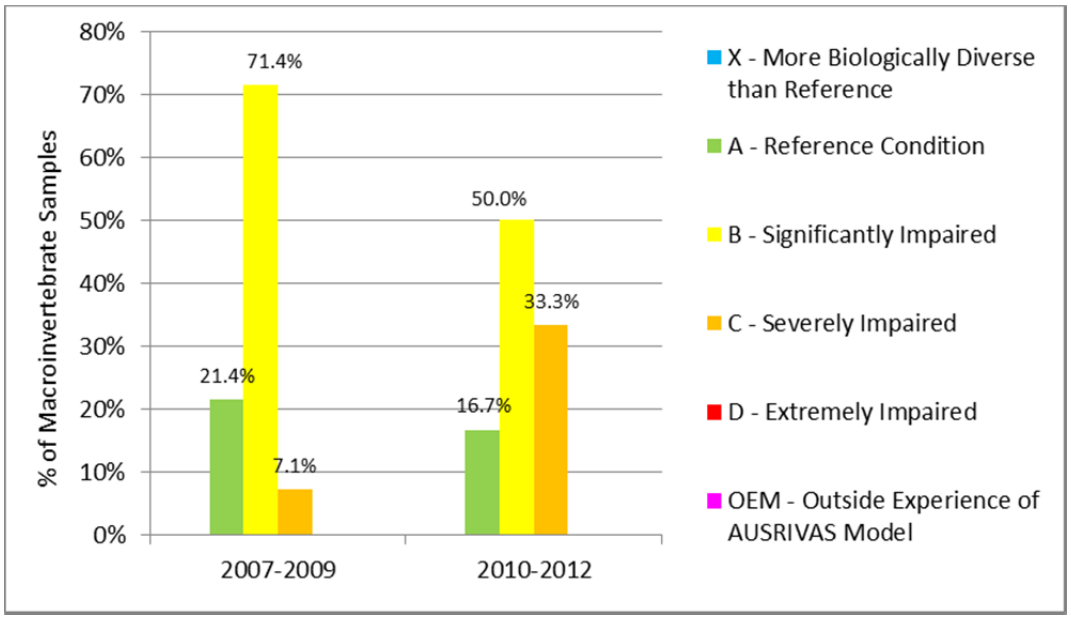
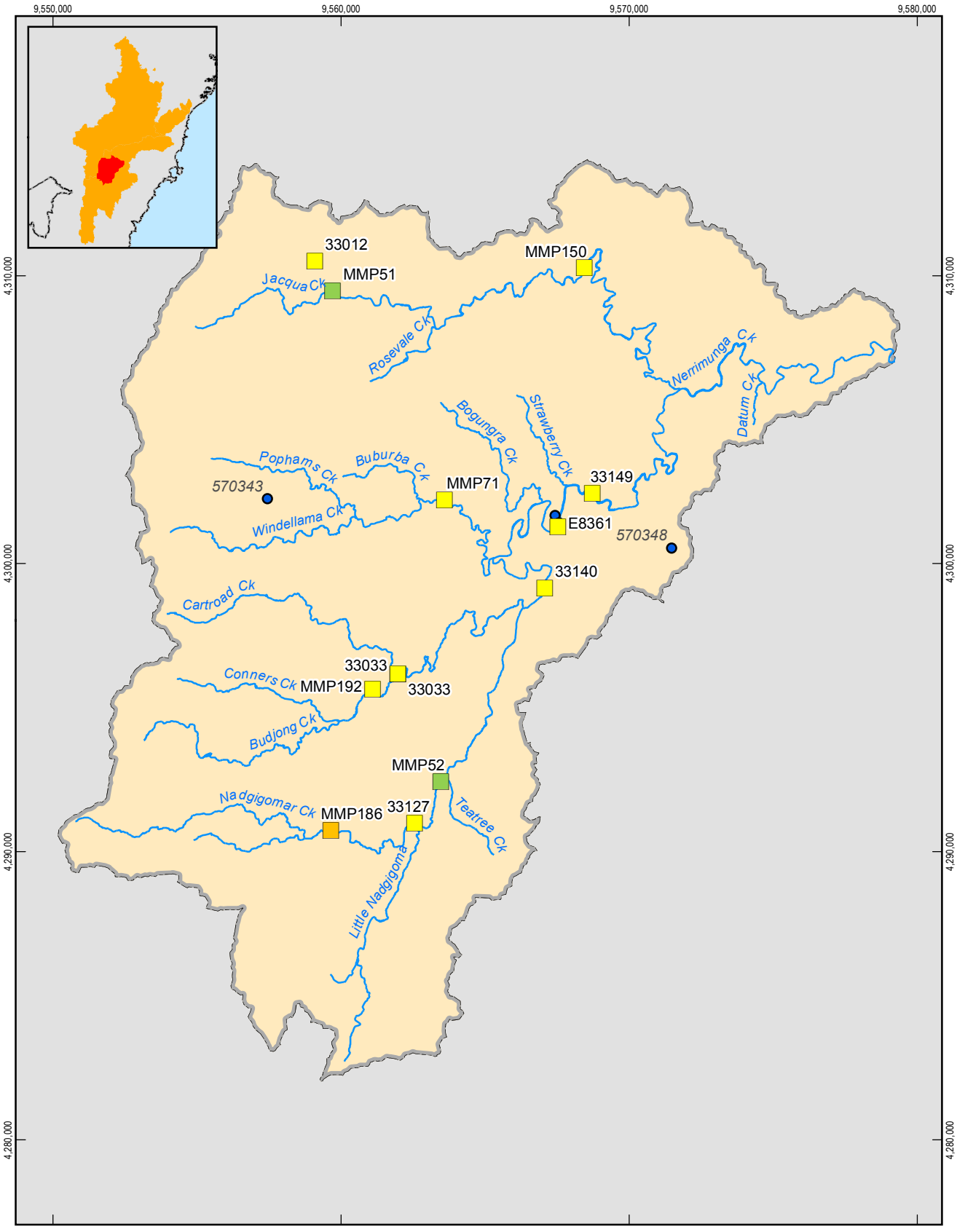


Figure I 1-70 Comparison of AUSRIVAS results from the Nerrimunga Creek sub-catchment: 2007-09 to 2010-12

Two long-term core sites have been sampled and assessed each year since 2001 including , E8361 and MMP51. AUSRIVAS scores at E8361 have fluctuated over time, generally between reference condition (band A) and significantly impaired (band B), but samples collected in 2010 from both sites were rated as severely impaired (band C). Both sites then improved in the subsequent year and were rated as significantly impaired (band B), and while E8631 maintained this score in 2012, MMP51 improved further and received an AUSRIVAS rating of reference condition (band A) in 2012.

Gauging station data within the Nerrimunga Creek sub-catchment (Table I 1-42) showed no flow to occurr during the previous audit period but an increase in 2010 to 2013. This may by a key factor when considering the changes in the macroinvertebrate community data and ongoing monitoring of these cote long-term sites may provide further evidence of discharge influences

on the macroinvertebrate communities. Additional sampling sites, spread across the sub-catchment, would provide further evidence of catchment condition and detection of temporal changes.



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model

Water Quality Monitoring Site

Waterbody

Waterway

Sub-catchment Boundary

Focus Sub-catchment

Paper Size A4

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Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Catchment Audit 2013

Nerrimunga River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number 2314960
Revision 0
Date 26 Nov 2013

Figure I 1-71

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Level 6, 20 Smith Street Parramatta NSW 2150 Australia T 61 2 8898 8800 F 61 2 8898 8810 E ptamail@ghd.com W www.ghd.com

Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

Table I 1-41 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Nerrimunga Creek sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
33012	Edge	-34.92792	149.83753								B					
33033	Edge	-35.05642	149.87348								A					
33033	Edge	-35.05642	149.87348								B					
33127	Edge	-35.1031	149.88142										B			
33140	Edge	-35.02843	149.92841										B			
33149	Edge	-34.99815	149.94546										B			
E8361	Edge	-35.00894	149.93277		A	A	B	A	B	B	A	B	A	C	B	B
MMP150	Edge	-34.92777	149.94012						B							
MMP186	Edge	-35.10602	149.84945									C				
MMP192	Edge	-35.06143	149.864							B						
MMP51	Edge	-34.93714	149.84472		A	A	C	B	A	B	B	B	B	C	B	A
MMP52	Edge	-35.08992	149.89097			A										
MMP71	Edge	-35.00168	149.88931				OEM				B					

Water availability

Surface water flows

Flow data from one gauge within the Nerrimunga Creek sub-catchment was considered under this current audit. The assessment of this gauge is consistent with previous audits. Table I 1-42 identifies the gauge assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-42 Flow (ML/day) at gauging stations in the Nerrimunga Creek sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
215240	Nerrimunga Creek at Minshull Trig	03/12/1994	0.08	0.00	0.19	0.00	0.27

The Nerrimunga Creek (at Minshull Trig Station) does not flow for large proportions of the year (long-term average 53% of days with no flow). During the audit period, the river did not flow on approximately 35% of days, indicating more flow days than the long-term average. The flow exceedance curve shows that flows were higher than both the long-term average and the previous audit periods for the full flow exceedance spectrum. The 10% exceedance flow during the audit period was 36 ML/day, compared to the long term 10% exceedance flow of just 6.3 ML/day.

Catchment and storage water quality

Long-term water quality monitoring in the Nerrimunga Creek sub-catchment was available up until 2004 from the SCA's monitoring site at Minshall Trig (site E8361). This site was discontinued as a routine water quality monitoring site. No long-term water quality monitoring data for storages in the Nerrimunga Creek sub-catchment was available for the 2010-13 audit period.

1.19 Bungonia Creek

1.19.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Bungonia Creek sub-catchment are shown in Figure I 1-72.

Conservation and Natural Environments (63%) is the main land use in the sub-catchment and this primarily consist of Nature conservation (46.7%) and Other minimal use (16.4%). Production from Dryland Agriculture and Plantations (29.7%) also contributes to a major proportion of land use with the vast majority of this class attributed to the tertiary class of Grazing modified pastures (28.6%). Intensives Uses (5.7%) make most of the remaining land use and much of this is taken by Residential and farm infrastructure (4.2%), with some land use also attributed to Transport and communication (0.7%) and Mining (0.4%) is also undertaken in the sub-catchment.

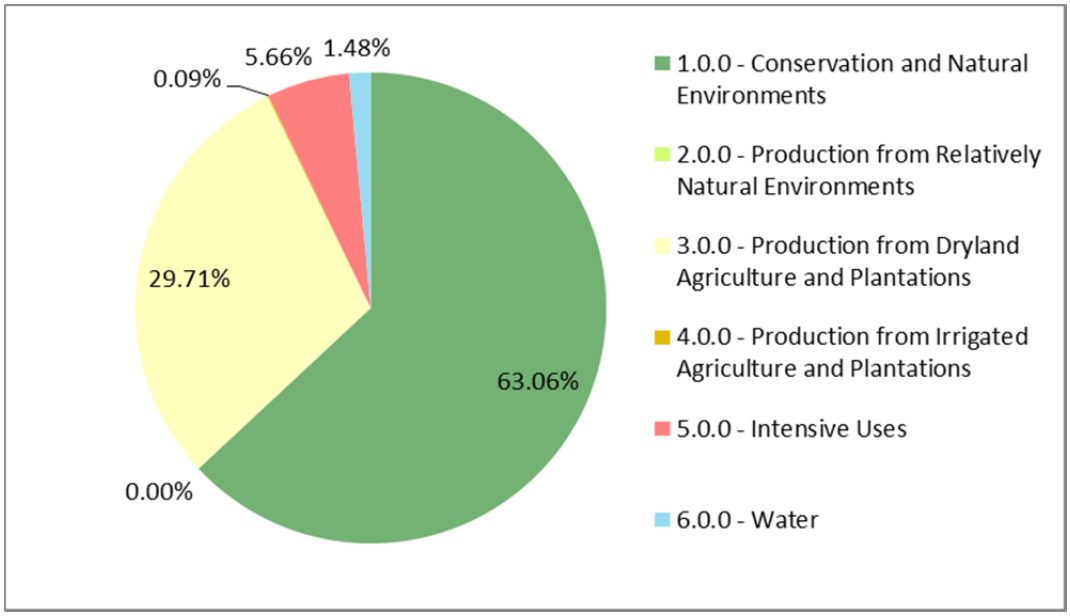


Figure I 1-72 Land use in the Bungonia Creek sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Bungonia Creek sub-catchment were primarily sourced from the SCA macroinvertebrate monitoring program with historic data for one site provided by OEH. The results are summarised in Figure I 1-73, Figure I 1-75 and Table I 1-43.

Data on macroinvertebrates in the Bungonia Creek sub-catchment were available from 10 sites four of which had riffle habitat present at the time of sampling and sample data for a total of 45 samples was provided.

The majority of samples were assessed by AUSRIVAS to be reference condition (band A) (43.5%), followed a large proportion of samples rated significantly impaired (band B) (34.8%) and some severely impaired (band C) site samples (8.7%). Samples were also relatively frequently outside the experience of the AUSRIVAS model (10.9%) and on sample could not be collected from the long-term monitoring site (A8) in 2002 as the site was dry.

Two core sites have been consistently sampled and assessed each year since 2001 including E847 and A8, which is edge habitat only, and samples from these sites make up the majority of samples collected within the sub-catchment. AUSRIVAS scores at both core sites have generally fluctuated between reference condition (band A) and significantly impaired (band B) however, like many other of the southern catchments sites, E457 observed a decline to severely impaired (band C) in 2010, followed by a recovery back to reference condition (band A) in subsequent years. Samples from A8 collected in 2010 and 2012 were outside the experience of the AUSRIVAS model which may suggest a change in condition however additional data (such as SIGNAL 2 and EPT richness scores) would be required to determine if this represented a decline in condition of the macroinvertebrate community.

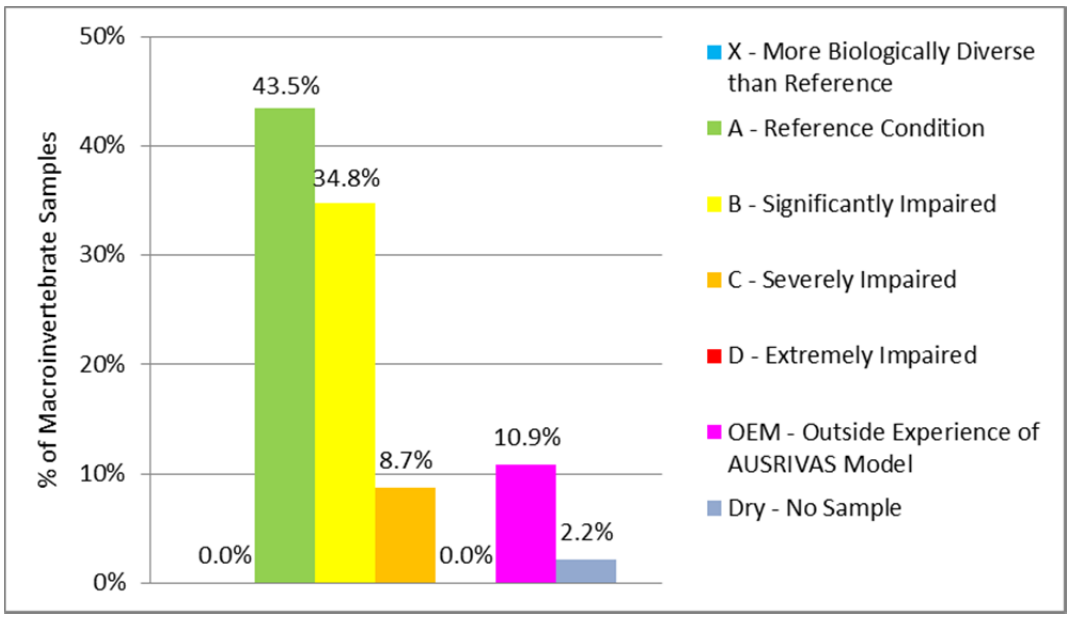


Figure I 1-73 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for for the Bungonia Creek sub-catchment

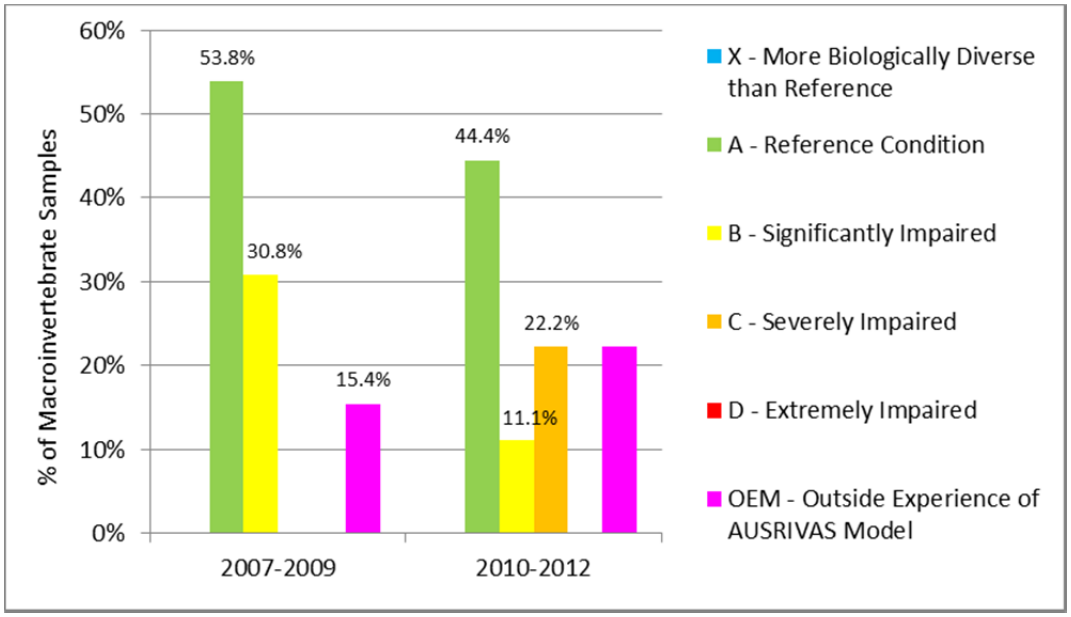
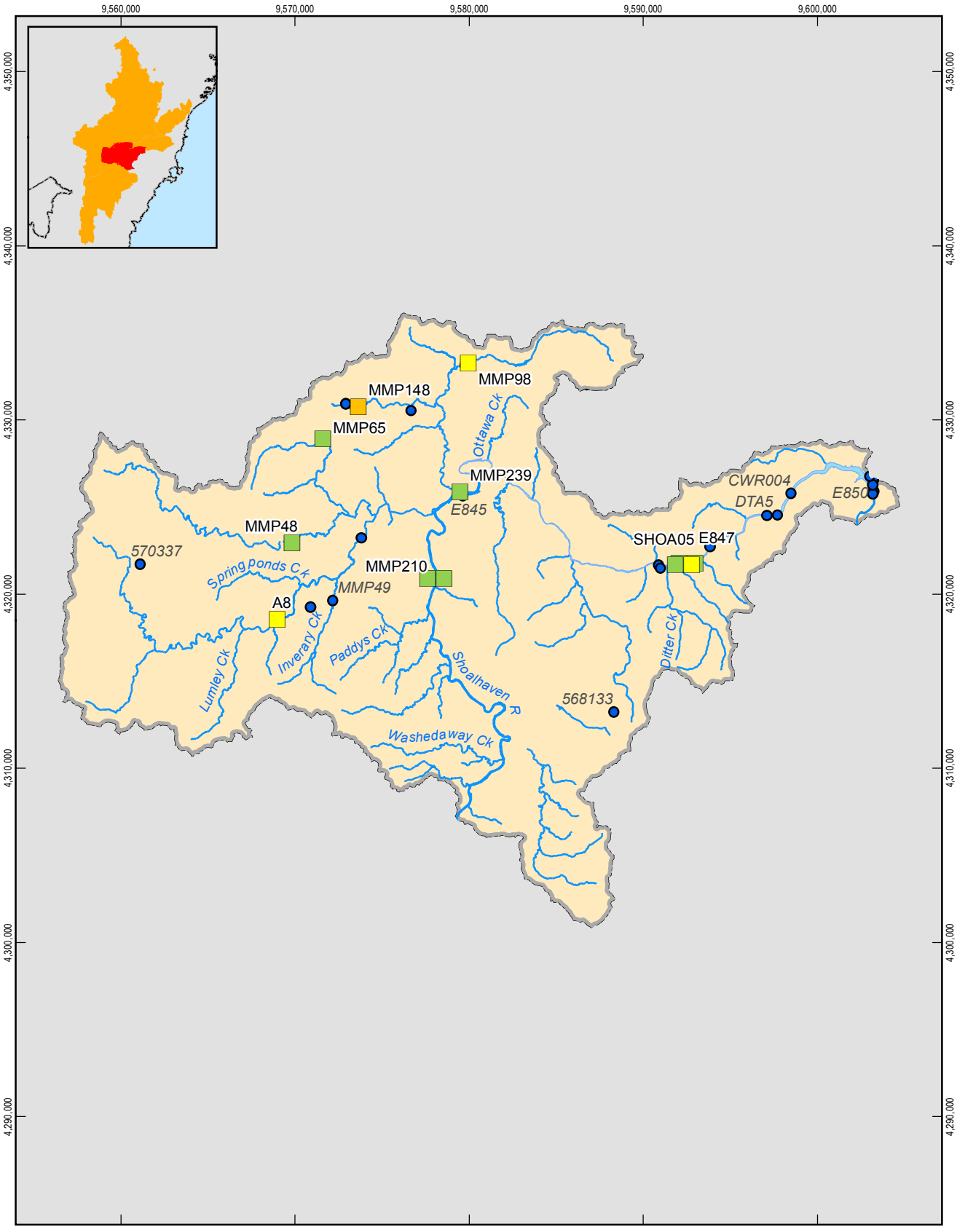


Figure I 1-74 Comparison of AUSRIVAS results from the Bungonia Creek sub-catchment: 2007-09 to 2010-12



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model
- *Water Quality Monitoring Site*
- Waterbody
- Waterway
- Sub-catchment Boundary
- Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Sydney Catchment Authority
Catchment Audit 2013

Bungonia Creek Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number	2314960
Revision	0
Date	26 Nov 2013

Figure I 1-75

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Level 6, 20 Smith Street Parramatta NSW 2150 Australia T 61 2 8898 8800 F 61 2 8898 8810 E ptamail@ghd.com W www.ghd.com

Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

Table I 1-43 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Bungonia Creek sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
A8	Edge	-34.853028	149.94336		B	dry	B	B	A	B	A	B	B	OEM	B	OEM
E847	Edge	-34.8175	150.20076		OEM	A	B	A	B	B	OEM	B	A	C	A	A
E847	Riffle	-34.8175	150.20076				A	B	B	A	OEM	A	A	C	A	A
MMP148	Edge	-34.74178	149.99039						C							
MMP210	Edge	-34.82937	150.04338							A						
MMP210	Riffle	-34.82937	150.04338							A						
MMP229	Edge	34.80972	149.994967									A				
MMP229	Riffle	34.80972	149.994967									B				
MMP239	Edge	-34.78431	150.05571								A					
MMP48	Edge	-34.81325	149.95138			A										
MMP65	Edge	-34.75888	149.96889				A									
MMP98	Edge	-34.71746	150.0587					B								
SHOA05	Edge	-34.8183	150.19846	C									A			
SHOA05	Riffle	-34.8183	150.19846	B												

Water availability

Surface water flow

Flow data from two gauges within the Bungonia Creek sub-catchment was considered under this current audit. The assessment of this gauge is consistent with previous audits. Table I 1-44 identifies the gauge assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-44 Flow (ML/day) at gauging stations in the Bungonia Creek sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
215014	Bungonia Creek at Bungonia	15/04/1981	0.90	0.32	0.38	0.39	0.78
215207	Shoalhaven River at Fossickers Flat	15/07/1977	364.22	174.43	132.13	132.64	495.88

Flows in Bungonia Creek at Bungonia (monitor 215014) during the audit period were lower than the long-term average, yet higher than the three previous audit periods over the entire flow exceedance range. No flow was recorded on approximately 8% of days during the audit period, which is close to the long-term average.

Flows in the Shoalhaven River at Fossicker's Flat (monitor 215207) during the current audit period were higher than the long-term average (median 496 ML/day vs. long-term median 364 ML/day) and significantly higher than the last three audit periods over the whole flow exceedance range. This reflects the trend for higher-than-normal flows in the audit period for all Shoalhaven River gauges.

Catchment water quality

Long-term water quality monitoring in the Bungonia Creek catchment is available from the SCA's long-term river water quality monitoring site on the Shoalhaven River at Fossickers Flat (E847) and the Shoalhaven River downstream Tallowa Dam (E851). No data was made available to the auditor for E851 for the current audit period.

- The median TN concentration for E847 was 0.250 mg/L during the current audit; 48% of recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was slightly less than range of recordings in previous audits (median values for previous five audits ranged from 0.300 to 0.800 mg/L). A significant long-term trend was detected with concentrations decreasing by 0.004 mg/L per year.
- During the current audit the median TP concentration for E847 was 0.015 mg/L; 41% of recordings above the ANZECC guideline for upland rivers. The median TP concentration during the current audit was similar to the range of values found in previous audits

(median values for previous five audits ranged from 0.010 to 0.084 mg/L). No significant long-term trend was detected for TP at E847.

- The median electrical conductivity for E847 was 0.104 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for upland rivers. The median conductivity during the current audit was similar to other audits (median values for previous five audits range from 0.087 to 0.134 mS/cm). There was no significant long-term trend detected for conductivity at E847.
- The median chlorophyll à concentration for E847 was 2.1 µg/L during the current audit; 5% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was generally similar to other audits (median values for previous five audits ranged from 0.5 to 3.7 µg/L). However, a significant long-term trend was detected with concentrations increasing by 0.1 µg/L per year.

Storage water quality

Long-term water quality monitoring in the Bungonia Creek sub-catchment is undertaken by the SCA at Lake Yarrunga (DTA1) and the Shoalhaven River Arm of Lake Yarrunga (DTA5).

DTA1 - Lake Yarrunga

- The median TN concentration for DTA1 was 0.400 mg/L during the current audit; 73% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was within the range of values recorded in previous audits (median values for five previous audits ranged from 0.310 to 0.400 mg/L). A significant long-term trend was detected with concentrations increasing by 0.041 mg/L per year.
- During the current audit the median TP concentration for DTA1 was 0.025 mg/L; 97% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was noticeably higher than for previous audits (median values for previous five audits ranged from 0.005 to 0.011 mg/L). A significant long-term trend was detected for TP with concentrations increasing by 0.007 mg/L per year.
- For DTA1 the median electrical conductivity during the current audit was 0.097 mS/cm; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was within the range of values recorded in previous audits (median value for previous four audits ranged from 0.089 to 0.103 mS/cm). A significant long-term trend was detected with conductivity increasing at 0.004 mS/cm per year.
- The median chlorophyll à concentration at DTA1 during the current audit was 2.9 µg/L; 24% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was less than the range of values recorded for previous audits (median values for five previous audits ranged from 3.2 to 4.9 µg/L). No significant long-term trend was detected for chlorophyll à at DTA1.

DTA5 - Shoalhaven River Arm of Lake Yarrunga

- The median TN concentration for DTA5 was 0.430 mg/L during the current audit; 68% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TN concentration during the current audit was higher than previous audits

(median values for previous five audits ranged from 0.300 to 0.400 mg/L). No significant long-term trend was detected for TN at DTA5.

- For DTA5 the median TP concentration was 0.030 mg/L during the current audit; 97% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median TP concentration during the current audit was greater than previous audits (median values for previous five audits ranged from 0.005 to 0.014 mg/L). No significant long-term trend was detected for TP at DTA5.
- The median electrical conductivity for DTA5 was 0.102 mS/cm during the current audit; no recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median conductivity during the current audit was within the range of values recorded in previous audits (median values for previous four audits ranged from 0.096 to 0.105 mS/cm). A significant long-term trend was detected with conductivity increasing by only 0.005 mS/cm per year.
- During the current audit period the median chlorophyll à concentration for DTA5 was 2.5 µg/L; 22% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values recorded in previous audits (median values for previous four audits ranged from 2.3 to 5.65 µg/L). Despite this, a significant long-term trend was detected for chlorophyll à with concentrations decreasing by 0.59 µg/L per year.

1.20 Boro Creek

1.20.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Boro Creek sub-catchment are shown in Figure I 1-76.

Production from Dryland Agriculture and Plantations (50.1%) accounted for just over half of the land use within the Boro Creek sub-catchment and this was split among the tertiary classes of Grazing modified pastures (36.0%), Land in transition (10.8%) and Plantation forestry (3.3%). A small proportion of the catchment was attributed to Intensive Uses (5.8%), which was comprised mainly of Residential and farm infrastructure (4.9%), with some Transport and communication (0.5%) and Mining (0.3%). Water (2.0%) covered a small area of land and this was predominantly Rivers (1.4%).

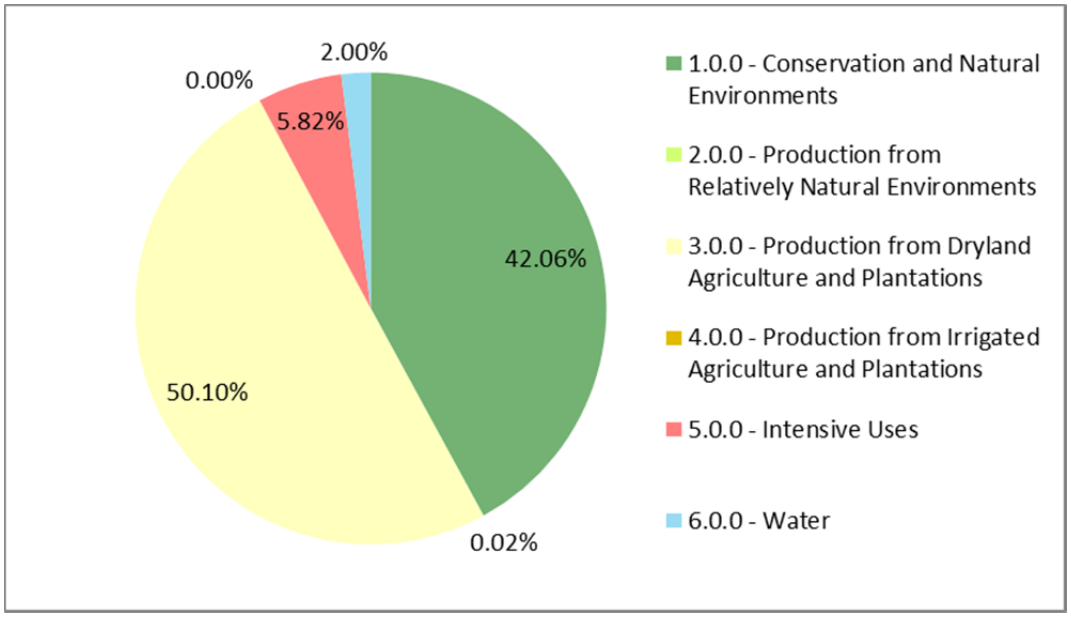


Figure I 1-76 Land use in the Boro Creek sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Boro Creek sub-catchment were sourced from the SCA macroinvertebrate monitoring program. The results are summarised in Figure I 1-77, Figure I 1-79 and Table I 1-45.

Data on macroinvertebrates in the Boro Creek sub-catchment was available from seven sites, all of which maintained edge habitat only. A total of 30 sampling attempts were made, only two of which were unsuccessful due to dry conditions, and AUSRIVAS results for a total of 28 samples was provided for analysis.

Considering all samples significantly impaired (band B) was the most common AUSRIVAS rating and exactly half of the samples received this rating. A further 30% of samples were rated as reference condition (band A) and the remaining samples were severely impaired (band C).

Two long-term core monitoring sites have been consistently sampled and assessed since 2001 including E890 and MMP33. Prior to 2010 AUSRIVAS scores at E890 generally fluctuated

between significantly impaired (band B) and reference condition (band A). However in 2010, the declining trend from 2007 continued and the site was assessed as severely impaired (band C). In the subsequent years the site then improved achieving a reference condition (band A) assessment in 2012.

The AUSRIVAS rating at MMP33 was assessed as reference condition (band A) in 2001, was dry the following year, and then consistently reference condition for the following three years. From 2006 results showed the condition of this site to decline and it was assessed as severely impaired (band C) during the lowest period in 2008 and 2009. AUSRIVAS results for MMP33 for the current audit period shows the site to improve slightly but the most recent result for this site was significantly impaired (band B).

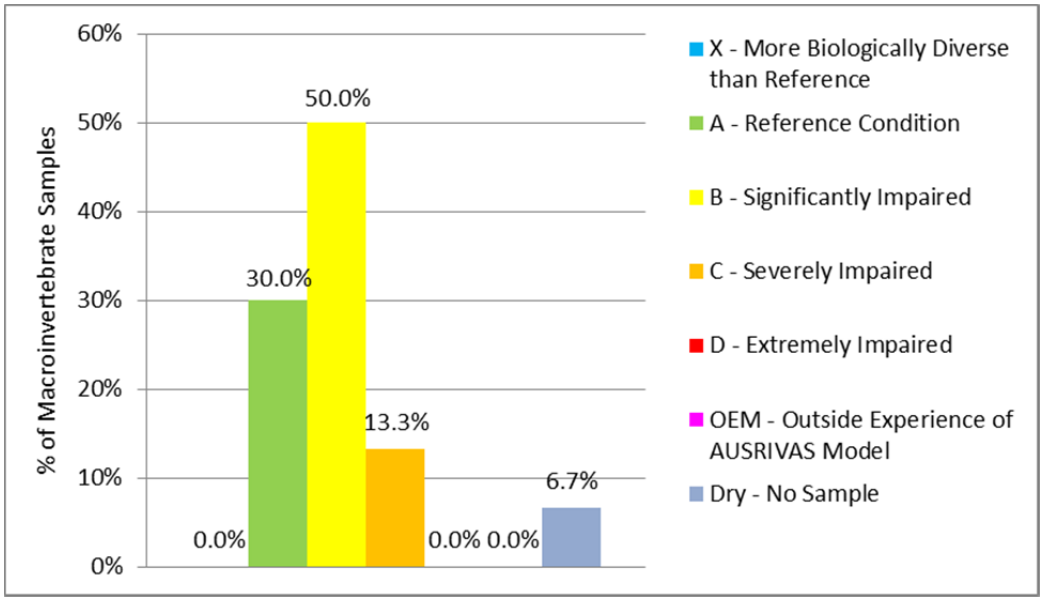


Figure I 1-77 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for for the Boro Creek sub-catchment

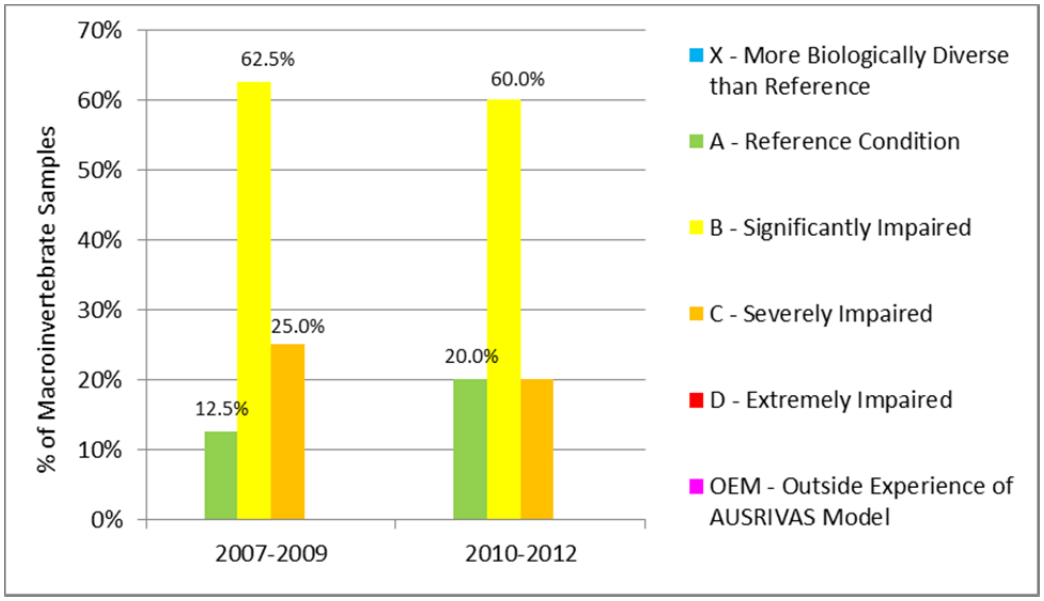
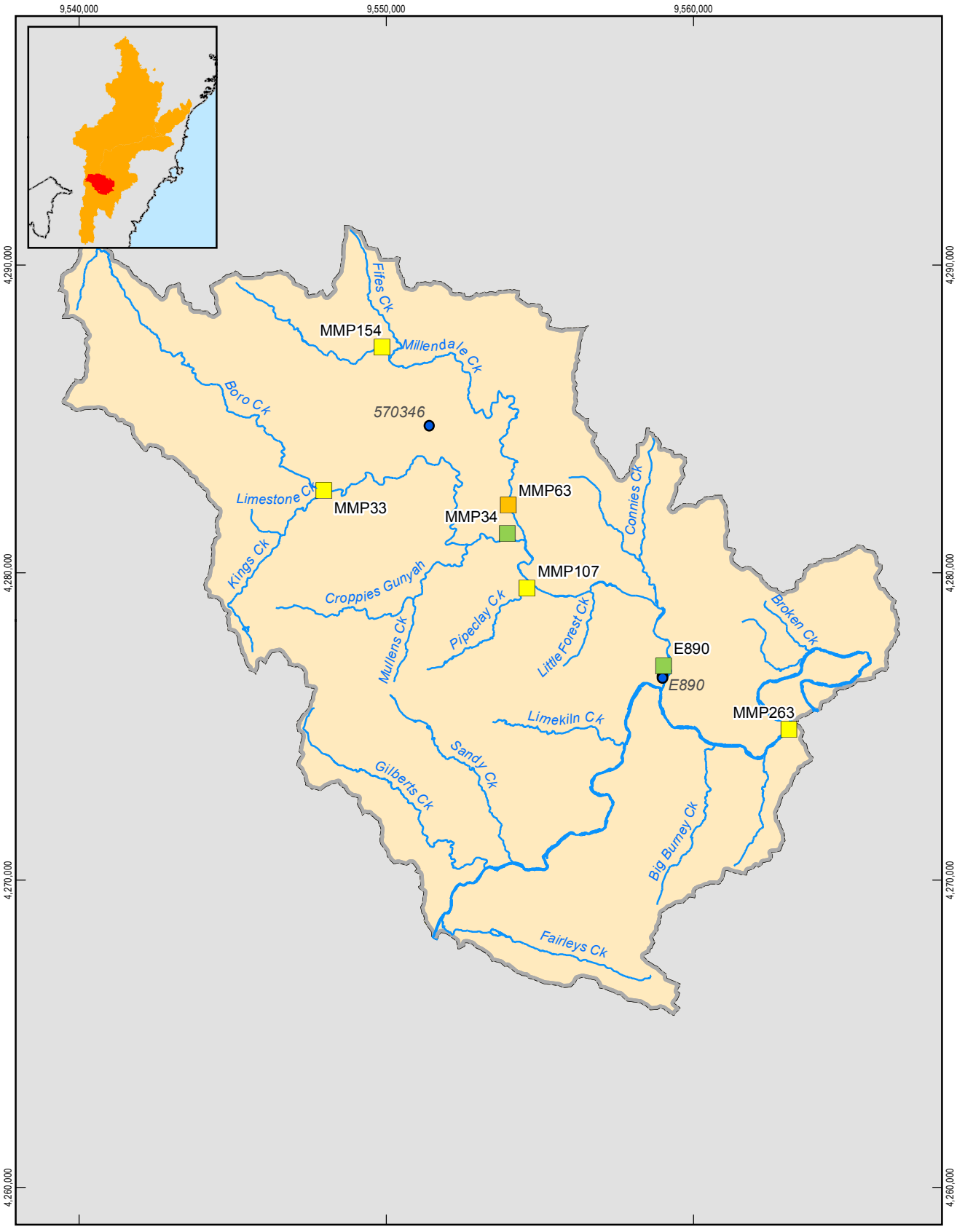


Figure I 1-78 Comparison of AUSRIVAS results from the Boro Creek sub-catchment: 2007-09 to 2010-12

The decline and recovery of macroinvertebrate communities as assessed by AUSRIVAS in the Boro Creek sub-catchment may coincide with the slight reduction and increase in flow (Table I 1-46) and associated water quality parameters. Overall the sites have not shown an obvious change and from comparison of the previous audit results to the current results (Figure I 1-78) a slight improvement in overall catchment condition is observed.



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model
- *Water Quality Monitoring Site*
- Waterbody
- Waterway
- Sub-catchment Boundary
- Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Sydney Catchment Authority
Catchment Audit 2013

Boro Creek Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number	2314960
Revision	0
Date	26 Nov 2013

Figure I 1-79

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Level 6, 20 Smith Street Parramatta NSW 2150 Australia T 61 2 8898 8800 F 61 2 8898 8810 E ptamail@ghd.com W www.ghd.com

Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

Table I 1-45 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Boro Creek sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
E890	Edge	-35.23021	149.84682		A	B	A	B	B	B	A	B	B	C	B	A
MMP107	Edge	-35.20869	149.79735					B			B					
MMP154	Edge	-35.13904	149.7432						B							
MMP263	Edge	-35.24792	149.89225									B				
MMP33	Edge	-35.18154	149.72373		A	dry	A	A	A	B	B	C	C		B	B
MMP34	Edge	-35.19277	149.78967			A										
MMP63	Edge	-35.18426	149.78983				dry			C						

Water availability

Surface water flow

Flow data from one gauge within the Boro Creek sub-catchment was considered under this current audit. The assessment of this gauge is consistent with previous audits. Table I 1-46 identifies the gauge assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-46 Flow (ML/day) at gauging stations in the Boro Creek sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
215239	Boro Creek at Marlowe	24/02/1994	3.65	3.25	2.35	2.03	2.11

The flows in Boro Creek at Marlowe during the audit period were typically lower than the long-term records over the bulk of the flow exceedance curve (median 2.11 ML/day vs. long-term 3.65 ML/day), however high flows during the audit period (80th percentile and up) were significantly higher than the long-term average. Low flows during the audit period were similar to the previous audit period; high flows were significantly higher than the previous audit period.

Catchment water quality

Long-term water quality monitoring in the Boro Creek sub-catchment is available from the SCA's water quality monitoring site on Boro Creek at Marlowe (E890).

- The median TN concentration for E890 was 0.300 mg/L during the current audit; 56% of recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was within the range for all previous audits (median values for previous five audits ranged from 0.170 to 0.415 mg/L). A significant long-term trend was detected with concentrations increasing by 0.007 mg/L per year.
- During the current audit the median TP concentration for E890 was 0.030 mg/L; 79% of recordings above the ANZECC guideline for upland rivers. The median TP concentration during the current audit was higher than previous audits (median values for previous five audits ranged from 0.008 to 0.020 mg/L). A significant long-term trend was detected with concentrations increasing by 0.003 mg/L per year.
- The median electrical conductivity for E890 was 0.118 mS/cm during the current audit; no recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was similar to previous audits (median values for previous five audits ranged from 0.074 to 0.225 mS/cm). A significant long-term trend was detected with conductivity increasing by 0.004 mS/cm per year.
- The median chlorophyll à concentration for E890 was 4.0 µg/L during the current audit; 23% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was greater than other audits (median values for previous five audits ranged from 1.0 to 3.0 µg/L). A significant long-term trend was detected with concentrations increasing by 0.35 µg/L per year.

Storage water quality

Not available.

1.21 Mid Shoalhaven River

1.21.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Mid Shoalhaven River sub-catchment are shown in Figure I 1-80.

The chief land use in the Mid Shoalhaven was the ALUM7 Class of Conservation and Natural Environments (61.9%) which was split between the tertiary classes of Other minimal use (43.1%) and Nature conservation (18.8%). Production from Dryland Agriculture and Plantations (32.2%) was the second most extensive land use in the sub-catchment and this was attributed to Grazing modified pastures (21.1%), Plantation forestry (8.7%) and Land in transition (2.4%). Intensive Uses (4.4%) contributed to a small proportion of the sub-catchment land use, the majority of which was due to the tertiary class of Residential and farm infrastructure (3.8%), with some Transport and communications (0.4%), Utilities (0.2%) and a very small portion of Mining (0.1%). Water (1.4%) also covered only a small portion of the sub-catchment, most of which was Rivers (1.9%).

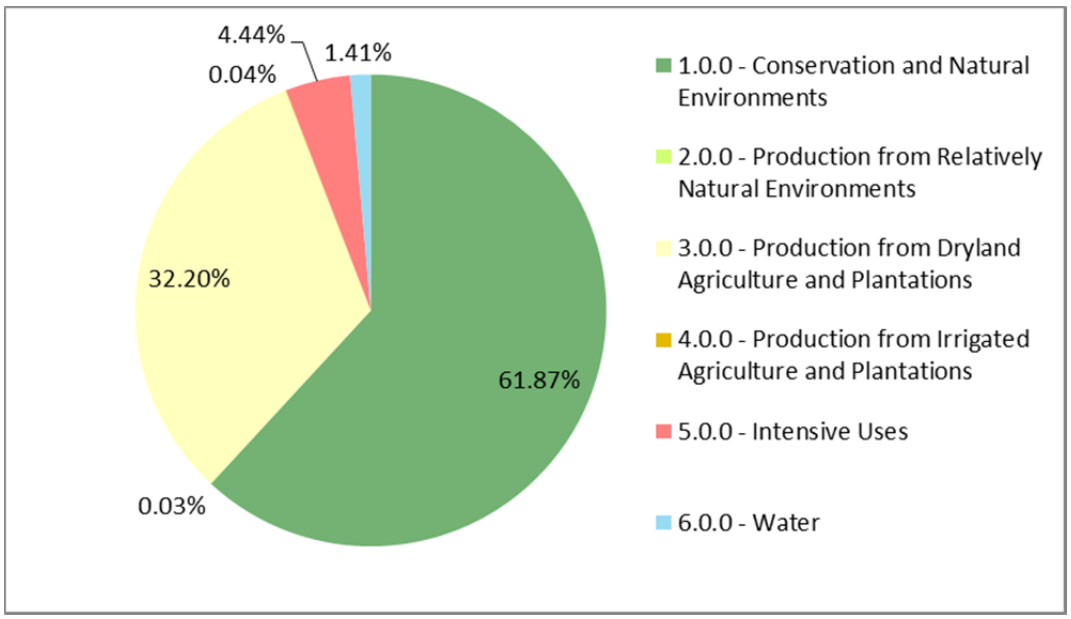


Figure I 1-80 Land use in the Mid Shoalhaven River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Mid Shoalhaven River sub-catchment were predominantly sourced from the SCA macroinvertebrate monitoring program with some historic data, and data for an additional two sites, sampled only in 2007, provided by OEH. The results are summarised in Figure I 1-81, Figure I 1-83 and Table I 1-47.

Data on macroinvertebrates in the Mid Shoalhaven River sub-catchment were available from 15 sites, of which 10 sites had riffle habitat. Data for a total of 50 site samples was provided, most of which were collected from the two long-term core monitoring sites E8311 and E861. Considering all AUSRIVAS results available for the sub-catchment 50% of samples were assessed as reference condition which suggests the catchment is generally in a good condition.

As with other sites within the southern SCA catchments, the two core sites of the Mid Shoalhaven River sub-catchment, which have been sampled and assessed relatively consistently since 2001, have fluctuated from more biologically diverse than reference (band X) to significantly impaired (band B). Similar to other southern catchments both these core sites received their lowest AUSRIVAS rating in 2010 and all three samples (two edge, one riffle) collected in that year were assessed as severely impaired (band C). A recovery was then evident at both sites in 2011 but E861 then declined again in 2012. The flows within the sub-catchment are likely a key driver of macroinvertebrate community condition and the increased flows experienced in the current audit period may provide some explanation of the change in AUSRIVAS ratings.

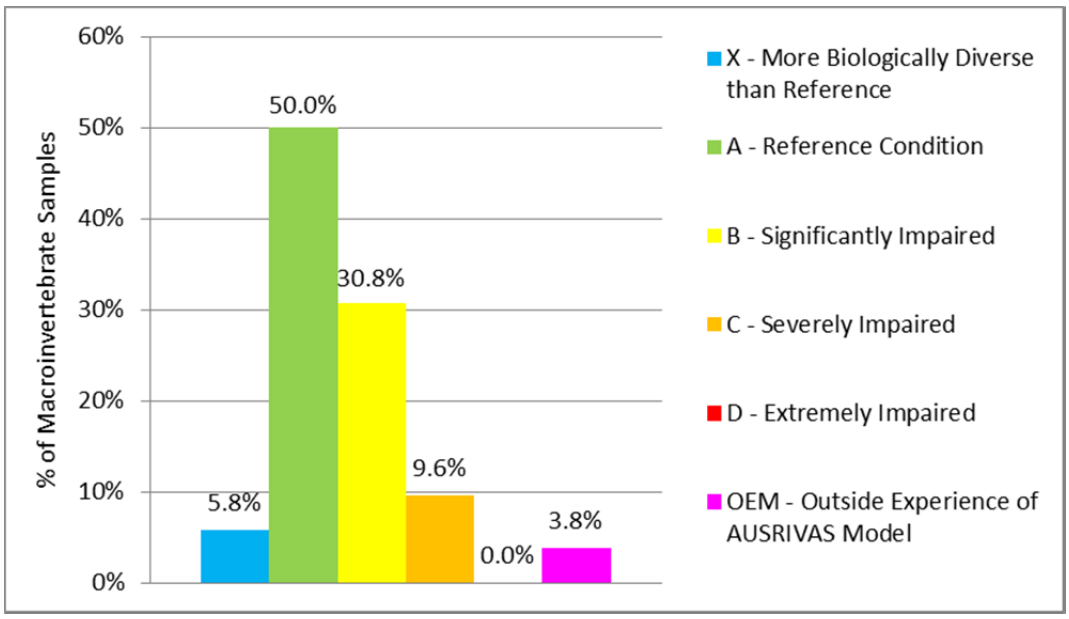


Figure I 1-81 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Mid Shoalhaven River sub-catchment

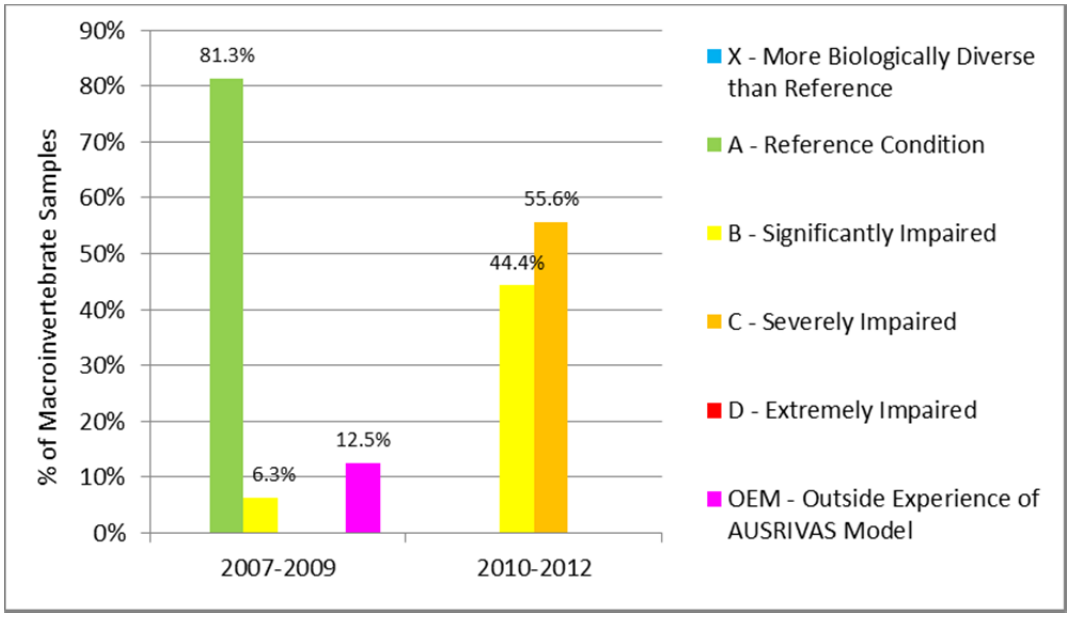
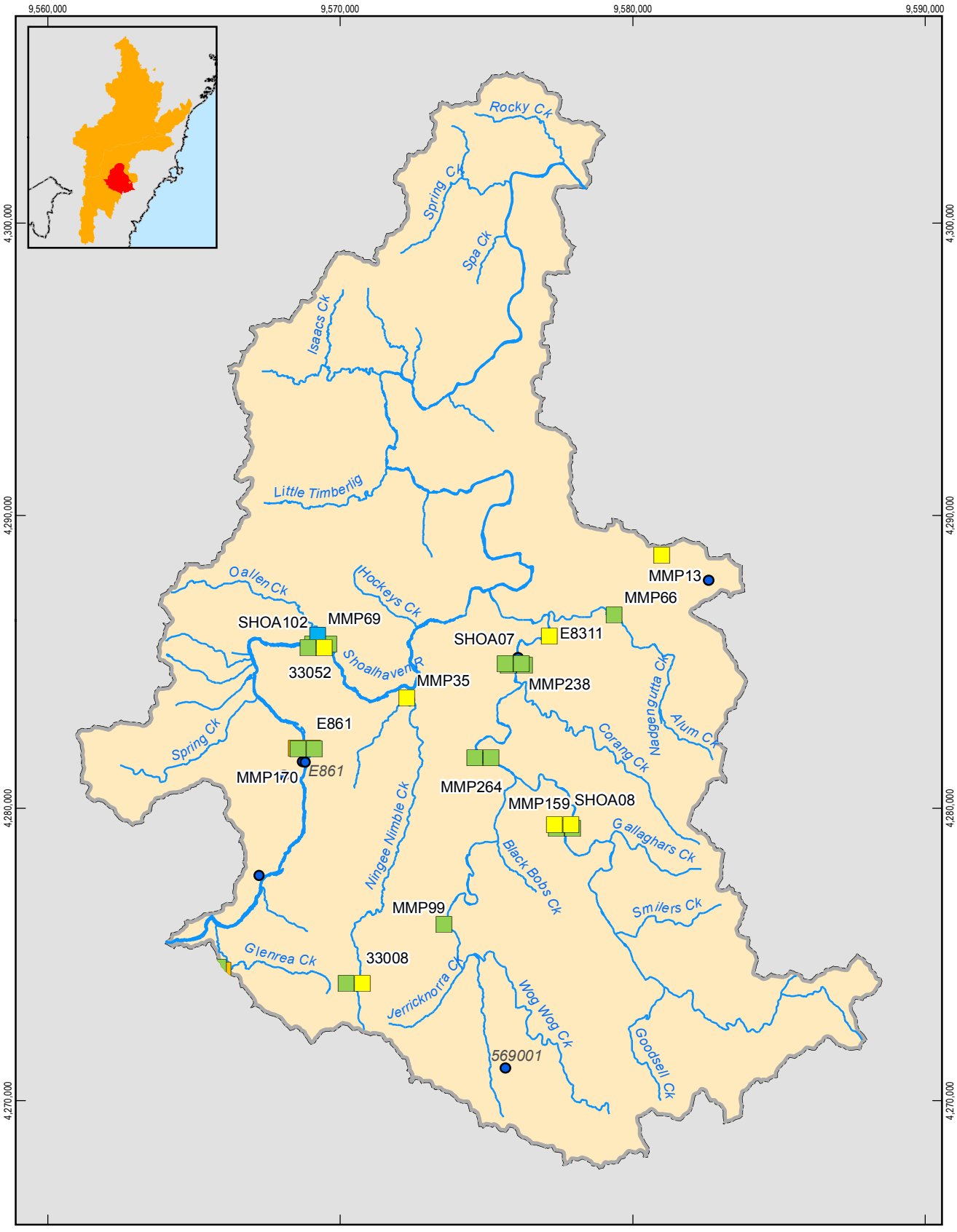


Figure I 1-82 Comparison of AUSRIVAS results from the Mid Shoalhaven River sub-catchment: 2007-09 to 2010-12



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

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- D - Extremely Impaired
- OEM - Outside Experience of Model

Water Quality Monitoring Site

Waterbody

Waterway

Sub-catchment Boundary

Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Sydney Catchment Authority
Catchment Audit 2013

Mid Shoalhaven River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number 2314960
Revision 0
Date 26 Nov 2013

Figure I 1-83

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Table I 1-47 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Mid Shoalhaven River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
33008	Edge	-35.25412	149.97412								A					
33008	Riffle	-35.25412	149.97412								B					
33052	Edge	-35.14978	149.95791								A					
33052	Riffle	-35.14978	149.95791								A					
E8311	Edge	-35.14543	150.04317		A	A	X	B	B	B			A	C	B	B
E861	Edge	-35.18208	149.953		B	X	A	B		A	A	A	A	C	B	C
E861	Riffle	-35.18208	149.953				B	A			A			C	B	C
MMP159	Edge	-35.20445	150.05156						A							
MMP159	Riffle	-35.20445	150.05156						A							
MMP170	Edge	-35.18214	149.95369						A			OEM				
MMP170	Riffle	-35.18214	149.95369						A			OEM				
MMP238	Edge	-35.15467	150.03176								A					
MMP238	Riffle	-35.15467	150.03176								A					
MMP264	Edge	-35.1835	150.02002									A				
MMP264	Riffle	-35.1835	150.02002									A				
MMP35	Edge	-35.16561	149.99028							B						
MMP66	Edge	-35.13824	150.06719				B				A					
MMP69	Edge	-35.14722	149.95611				X									
MMP99	Edge	-35.2352	150.0067					A								
SHOA07	Edge	-35.1542	150.0305	A												
SHOA07	Riffle	-35.1542	150.0305	A												
SHOA08	Edge	-35.2034	150.0507	B												
SHOA08	Riffle	-35.2034	150.0507	B												
SHOA102	Edge	-35.151	149.9562	A												
SHOA102	Riffle	-35.151	149.9562	B												

Water availability

Surface water flows

Flow data from three gauges within the Mid Shoalhaven River sub-catchment was considered under this current audit. The assessment of these gauges is consistent with previous audits. Table I 1-48 identifies the gauges assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-48 Flow (ML/day) at gauging stations in the Mid Shoalhaven River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
215242	Corang River at Meangora	03/12/1994	21.03	13.43	14.21	14.79	34.51
215004	Corang River at Hockeys	08/09/1924	25.79	14.55	17.79	17.78	35.46
215208	Shoalhaven River at Hillview	07/11/1973	301.90	130.67	78.50	96.39	340.72

Flows in the Shoalhaven River at Hillview (monitor 215208) during the current audit period were slightly higher than the long-term average (median 340 ML/day vs. long-term median 302 ML/day) and significantly higher than the last three audit periods (median 79 ML/day). During the audit period, low flows occurred less often than average. This reflects the trend for higher-than-normal flows in the audit period for all Shoalhaven River gauges.

There are two gauges on the Corang River approximately 500 m apart. Flow results at these two gauges are generally within 2% of each other. The Corang River at Hockeys gauge (monitor 215004) has 70 years more records than the Corang River at Meangora gauge (monitor 215242), and will therefore be adopted for this comparison. Flows in the Corang River during the audit period (median 35.5 ML/day) were higher than long-term median (25.8 ML/day) and averages over the full spectrum of the flow exceedance curve, particularly in the high-exceedance (low flow) section. The 90% exceedance flow during the audit period was 13.4 ML/day, compared with the long-term average 90% exceedance flow of 2.4 ML/day.

Catchment water quality

Long-term water quality monitoring in the Mid Shoalhaven River catchment is available from the SCA's long-term river water quality monitoring sites on the Shoalhaven River at Hillview (E861) and the Corang River (E8311). However, there was no water quality data made available to the audit for E8311 for the current audit period.

- The median TN concentration for E861 was 0.415 mg/L during the current audit; 77% of recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was higher than the four previous audits (median

values for previous four audits ranged from 0.310 to 0.380 mg/L) but was similar to the 1995-98 audit (median value 0.450 mg/L). There was no significant long-term trend in TN for E861.

- During the current audit the median TP concentration for E861 was 0.038 mg/L; 77% of recordings above the ANZECC guideline for upland rivers. The median TP concentration during the current audit was higher than previous audits (median values for previous five audits ranged from 0.012 to 0.030 mg/L). A significant long-term trend was detected for TP with concentrations increasing by 0.001 mg/L per year.
- The median electrical conductivity for E861 was 0.113 mS/cm during the current audit; no recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was within the range of values recorded in other audits (median values for previous five audits ranged from 0.094 to 0.115 mS/cm). There was a significant long-term trend detected for conductivity at E861 with concentrations decreasing by 0.002 mS/cm per year).
- The median chlorophyll à concentration for E861 was 3.8 µg/L during the current audit; 33% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was higher than all other audits (median values for previous five audits ranged from 1.0 to 3.5 µg/L) although no significant long-term trend was detected.

Storage water quality

No long-term water quality monitoring data for storages in the Mid Shoalhaven River sub-catchment was made available to the auditor for the 2010-13 audit period.

1.22 Endrick River

1.22.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Endrick River sub-catchment are shown in Figure I 1-84.

Conservation and Natural Environments (88.2%) was by far the most extensive land use within the Endrick River sub-catchment and this was attributed to the tertiary classes of Nature conservation (61.7%) and Other minimal use (26.5%). Production from Dryland Agriculture and Plantations (10.7%) was the other primary land use class and this was chiefly due to the extent of Grazing modified pastures (10.7%), with very little Plantation forestry (0.04%). Water (0.6%) accounted for only a very small proportion of the sub-catchment land use and this was mainly Rivers (0.58%).

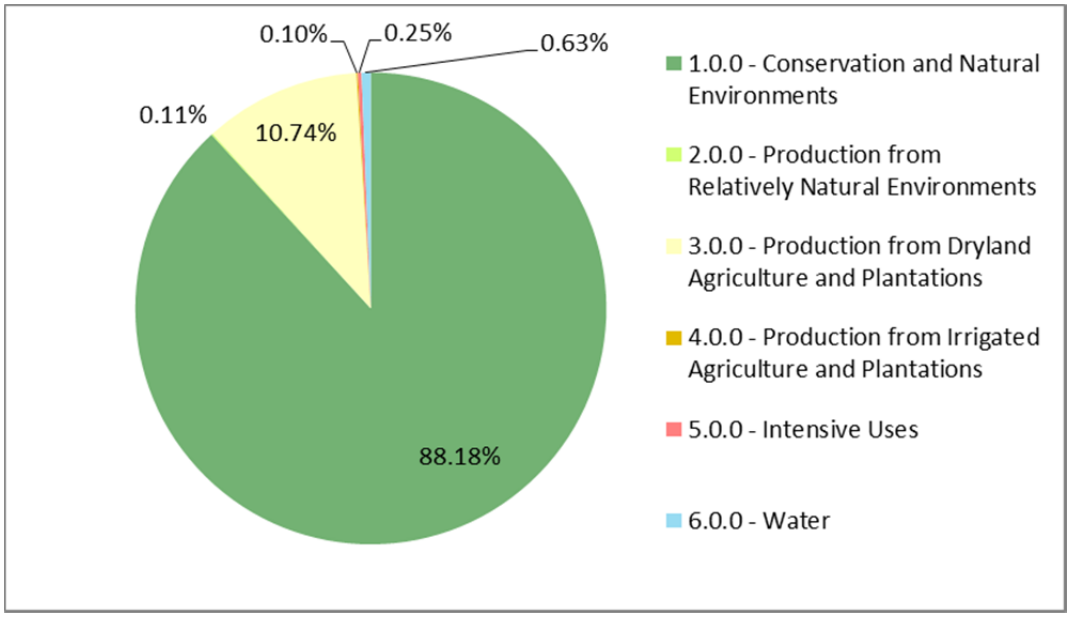


Figure I 1-84 Land use in the Endrick River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Endrick River sub-catchment were predominantly sourced from the SCA macroinvertebrate monitoring program with data for one additional site, sampled only in 2009, provided by OEH. The results are summarised in Figure I 1-85, Figure I 1-87and Table I 1-49.

AUSRIVAS results was provided for six sites within the Endrick River sub-catchment, only one of which had riffle habitat present, and one site for which sampling was attempted on one occasion but was dry. A total of 39 samples were attempted but due to dry conditions at three sites in separate years, only 36 sites samples have AUSRIVAS results for further analysis.

Across the sub-catchment, and considering the full temporal range of macroinvertebrate sampling, reference condition (band A) was the most frequent AUSRIVAS result, which suggests the Endrick River sites are in a relatively good condition.

Since 2001 two long-term core monitoring sites have been consistently sampled and assessed each year including MMP11 and MMP12. Although MMP12 did not maintain consistent riffle habitat the edge habitats of both sites generally maintained an reference condition (band A), or better, until 2010. As with other southern catchment sites these two Endrick River sub-catchment sites observed a steep decline in AUSRIVAS assessment condition (band A or X to band C) for the 2010 data. This score persisted through 2011 but improved slightly for the 2012 samples which all three samples were assessed as significantly impaired (band B).

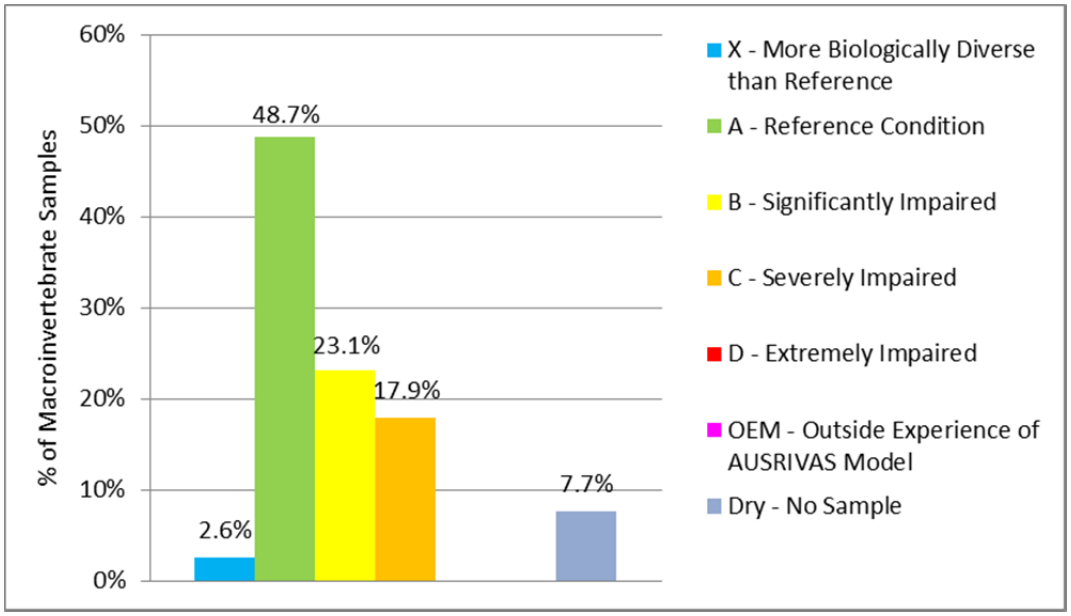


Figure I 1-85 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Endrick River sub-catchment

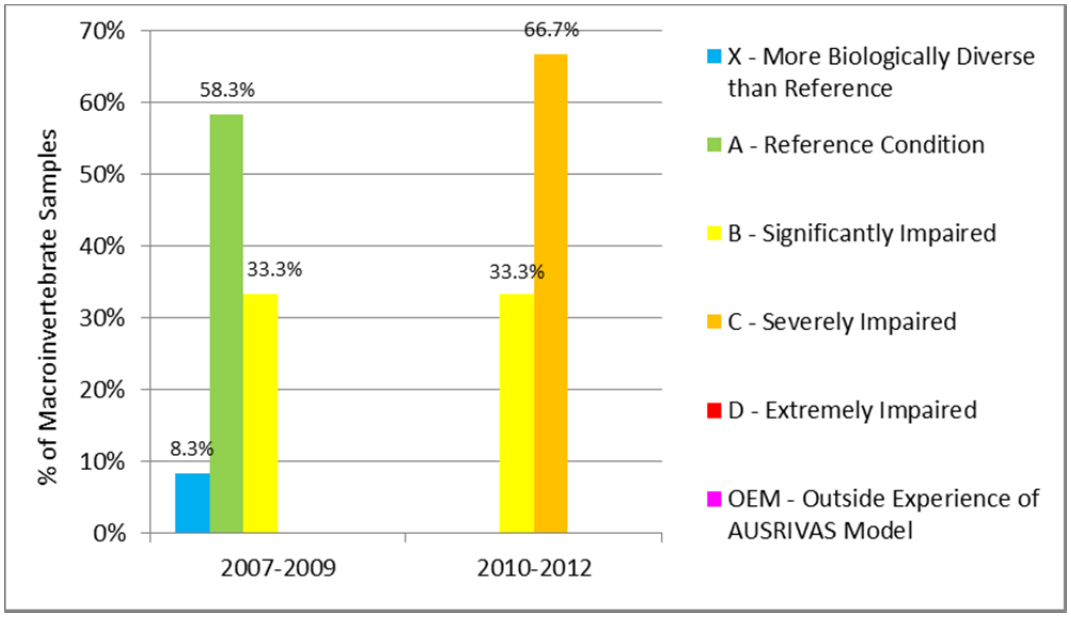
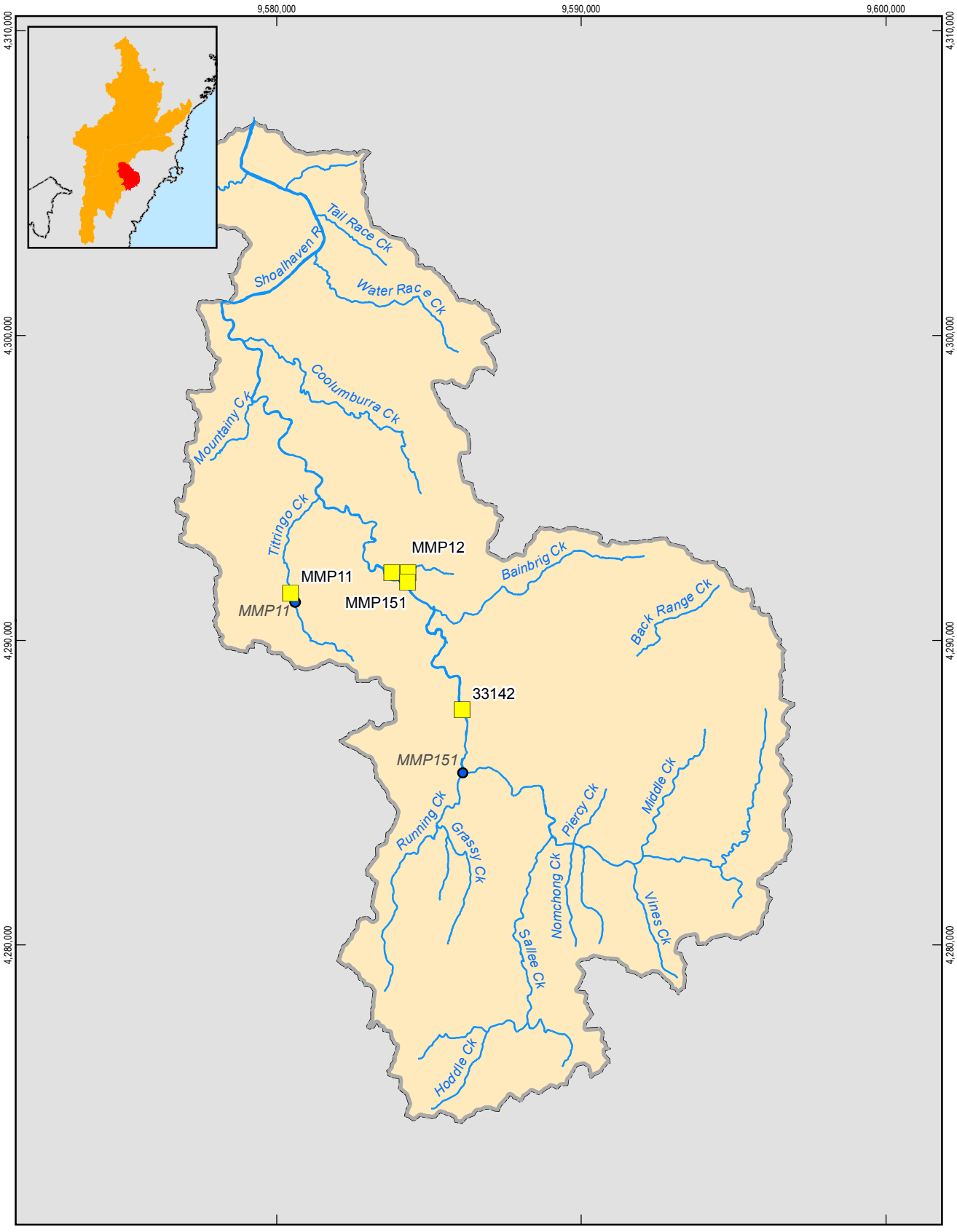


Figure I 1-86 Comparison of AUSRIVAS results from the Endrick River sub-catchment: 2007-09 to 2010-12

No flow data for the Endrick River sub-catchment was made available however a comment (see Catchment and storage water quality below) that the dominance of Conservation and Natural Environments within the catchment would suggest that water is likely to be of high quality. Flow volumes in surrounding catchments showed increases for the current audit period and this is

likely to be the case for the Endrick River also. This may offer some explanation of the drastic change in AUSRIVAS assessment observed from the previous audit compared to that of the current audit period (Figure I 1-86). Further and more widespread sampling accompanied by an analysis of water quality and quantity within the sub-catchment may provide a deeper understanding of the drivers of macroinvertebrate community composition and river health within the Endrick River sub-catchment.



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model
- *Water Quality Monitoring Site*
- Waterbody
- Waterway
- Sub-catchment Boundary
- Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Sydney Catchment Authority
Catchment Audit 2013

Endrick River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number	2314960
Revision	0
Date	26 Nov 2013

Figure I 1-87

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Table I 1-49 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Endrick River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
33142	Edge	-35.12647	150.14056										B			
MMP11	Edge	-35.09347	150.07766		A	A	A	A	A	A	A	A	A	C	C	B
MMP12	Edge	-35.08635	150.11734		A	A	A	A	B	A	A	A	X	C	C	B
MMP12	Riffle	-35.08635	150.11734				B	A			A	A	B	C	C	B
MMP13	Edge	-35.1194	150.08434			dry				C	B					
MMP151	Edge	-35.08916	150.11955						dry			B				
MMP97	Edge	-35.05398	150.11673					dry								

Water availability

No recent flow data was available for the Endrick River sub-catchment.

Catchment and storage water quality

The auditor was not made aware of any long-term water quality monitoring site in the Endrick River sub-catchment. However, given its largely protected catchment water quality could be expected to be good.

1.23 Reedy Creek

1.23.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Reedy Creek sub-catchment are shown in Figure I 1-88.

The primary land use within the Reedy Creek sub-catchment was Production form Dryland Agriculture and Plantations (61.6%) and this was predominantly attributed to Grazing modified pastures (54%) with some Land in transition (5.8%) and Plantation forestry (1.8%). The second most extensive land use class in the sub-catchment was Conservation and Natural Environments (28.9%) which was mostly due to the tertiary land use class of Other minimal use (21.8%) and Nature conservation (6.7%). The Intensive Uses (5.9%) class was largely Residential and farm infrastructure (5.3%) and Production forestry (2.2%) was the sole land use within the Production from Relatively Natural Environments land use class. Water (1.5%) covered only a small proportion of the sub-catchment and this was mostly due to Rivers (1.1%).

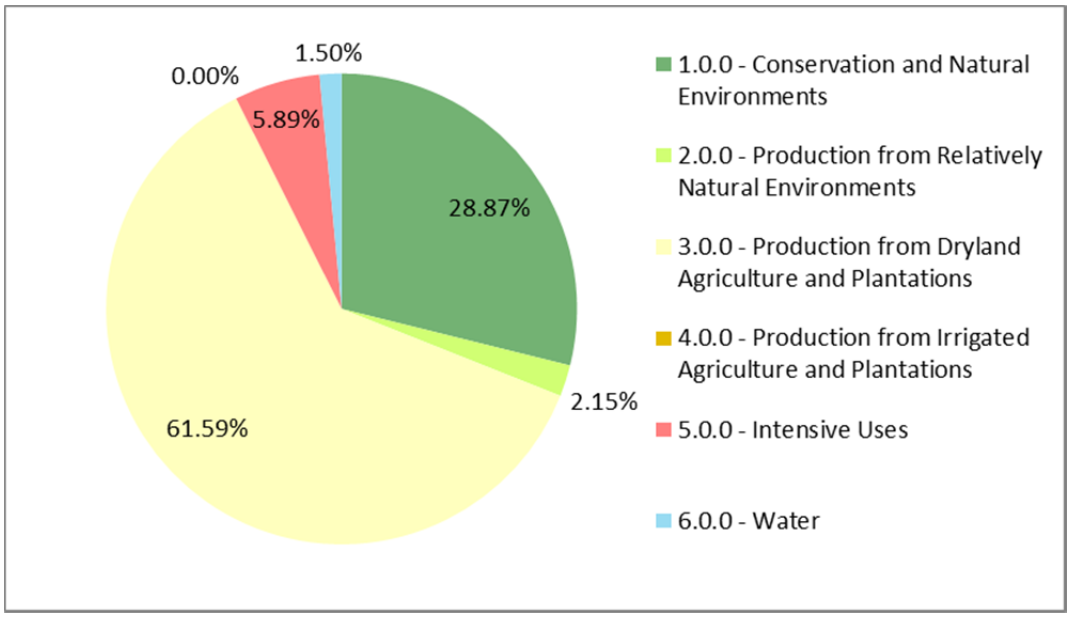


Figure I 1-88 Land use in the Reedy Creek sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Reedy Creek sub-catchment were primarily sourced from the SCA macroinvertebrate monitoring program with some historic data and data for two additional sites, sampled only in 2007, provided by OEH. The results are summarised in, Figure I 1-89, Figure I 1-91 and Table I 1-50.

Results of AUSRIVAS analysis was provided for 13 sites, only four of which had riffle habitat present at some time. Data for a total of 51 site samples was provided and these were predominantly collected from the core long-term monitoring sites of R7 and Reed1.

Considering all samples collected across the full temporal range of available samples for the Reedy Creek sub-catchment, the most common AUSRIVAS result was significantly impaired (band B) (45.1%) which suggests that overall catchment condition may be degraded to some

extent, although a relatively large proportion of samples were assessed as reference condition (band A) (43.1%) and A number of sites were assessed as severely impaired (band C) (11.8%)

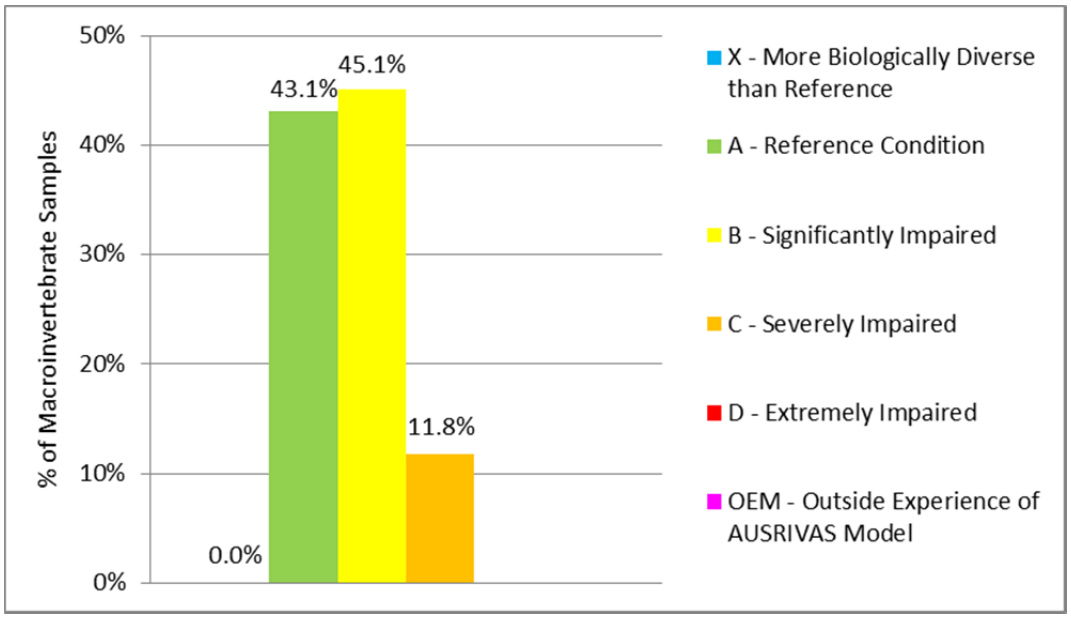


Figure I 1-89 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Reedy Creek sub-catchment

Two core sites, R7 and Reed1 (both with edge and riffle habitats) have been assessed each year since 2001. The previous audit found that AUSRIVAS scores generally fluctuated between reference condition (band A) and significantly impaired (band B); however, AUSRIVAS scores for each core site in 2009 were assessed as severely impaired (band C). Only results for edge habitat data was provided for both core sites in 2009 which suggests that low flow conditions may have limited the extent of riffle habitats within the sub-catchment generally reducing habitat complexity at the sub-catchment sites.

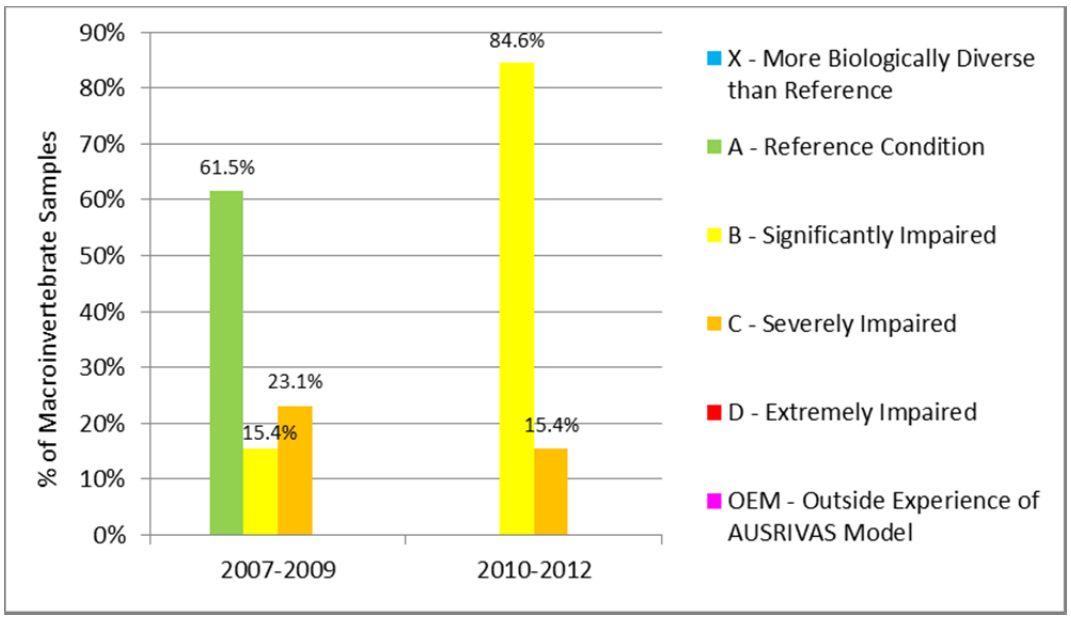
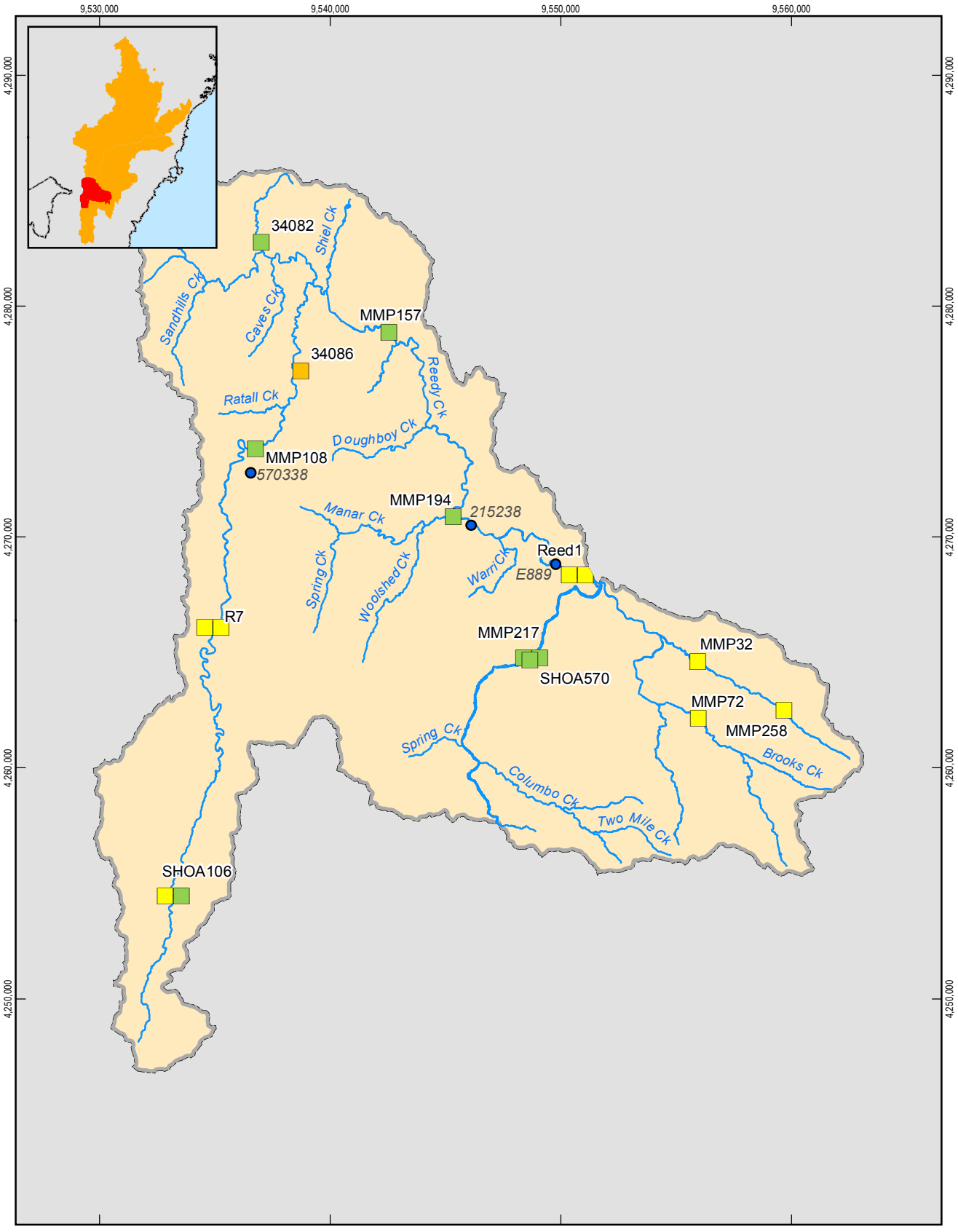


Figure I 1-90 Comparison of AUSRIVAS results from the Reedy Creek sub-catchment: 2007-09 to 2010-12

Analysis of flow data suggests some reduction of flows through Reedy Creek from 2004 to 2010 then a considerable increase for the current audit period (Table I 1-51). This may offer some explanation for the changes in macroinvertebrate community composition. However, unlike the preceding sub-catchments where low flows appeared to influence community stability the Reedy Creek communities may be accustomed to slightly higher flows which inundate riffle habitats.



LEGEND

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Paper Size A4

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Kilometres

Map Projection: Lambert Conformal Conic
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Sydney Catchment Authority
Catchment Audit 2013

Reedy Creek Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number	2314960
Revision	0
Date	26 Nov 2013

Figure I 1-91

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Table I 1-50 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Reedy Creek sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
34082	Edge	-35.18321	149.60346								A					
34086	Edge	-35.23305	149.62397								C					
MMP108	Edge	-35.26394	149.60322					A								
MMP157	Edge	-35.21708	149.66523						A							
MMP194	Edge	-35.2886	149.69828							A						
MMP217	Edge	-35.34263	149.73809								A					
MMP217	Riffle	-35.34263	149.73809								A					
MMP258	Edge	-35.3606	149.8585									A				B
MMP32	Edge	-35.34241	149.8167			B										
MMP72	Edge	-35.36466	149.81757				B									
R7	Edge	-35.33396	149.5859		A	A	B	B	A	A	A	A	C	B	B	B
R7	Riffle	-35.33396	149.5859				C		B					B	B	B
Reed1	Edge	-35.30999	149.759		A	A	A	A	B	B	A	B	C	C	B	B
Reed1	Riffle	-35.30999	149.759				A	B	B		A	B		C	B	B
SHOA106	Edge	-35.4392	149.5702	B												
SHOA106	Riffle	-35.4392	149.5702	A												
SHOA570	Edge	-35.3436	149.7366	A												

Water availability

Surface water flow

Flow data from two gauges within the Reedy Creek sub-catchment was considered under this current audit. The assessment of these gauges is consistent with previous audits. Table I 1-51 identifies the gauges assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-51 Flow (ML/day) at gauging stations in the Reedy Creek sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
215238	Reedy Creek at Manar	18/02/1995	5.03	2.55	0.10	0.14	17.66
215002	Shoalhaven River at Warri	02/09/1914	172.54	68.28	37.98	60.67	216.75

Flows in the Shoalhaven River at Warri (monitor 215002) during the current audit period were slightly higher than the long-term average (median 217 ML/day vs. long-term median 173 ML/day) and significantly higher than the last three audit periods (median 77 ML/day). During the audit period, low flows occurred less often than average. This reflects the trend for higher-than-normal flows in the audit period for all Shoalhaven River gauges.

Flows in the Reedy Creek at Manar (monitor 215238) were very low during the previous (2007-2010) audit period - approximately 40% of days recorded no flow (compared to the long-term average of 16%). The current audit period showed the opposite result - far higher than average flows, with no recorded periods of zero flow. Flows during the current audit period (median flow 17.7 ML/day) were significantly higher than the long-term median (5.0 ML/day). High flows were also much more frequent during the audit period than both the long-term average and the previous audit period (90th percentile flows of 127 ML/day, 54 ML/day and 8.1 ML/day respectively).

Catchment and storage water quality

Long-term water quality monitoring in the Reedy Creek sub-catchment was available up until 2004 from the SCA's long-term river water quality monitoring site on Reedy Creek at Manar (E889). This site was discontinued as a routine water quality monitoring site and no water quality data was available for either the current audit period or the 2004-07 and 2008-10 periods. No long-term water quality monitoring data for storages in the Reedy Creek sub-catchment was made available for the 2010-13 audit period.

1.24 Mongarlowe River

1.24.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Mongarlowe River sub-catchment are shown in Figure I 1-92.

Land use within the sub-catchment was split between the key land use classes of Production from Dryland Agriculture and Plantations (46.5%) and Conservation and Natural Environments (41.3%). Grazing modified pastures (32.9%) was the most extensive tertiary land use class, followed by Other minimal use (22.9%) and Nature conservation (16.1%). Land in transition (7.1%), Production forestry (5.8%) and Residential and farm infrastructure (3.9%) all contributed to small portions of the land use within the Mongarlowe River sub-catchment.

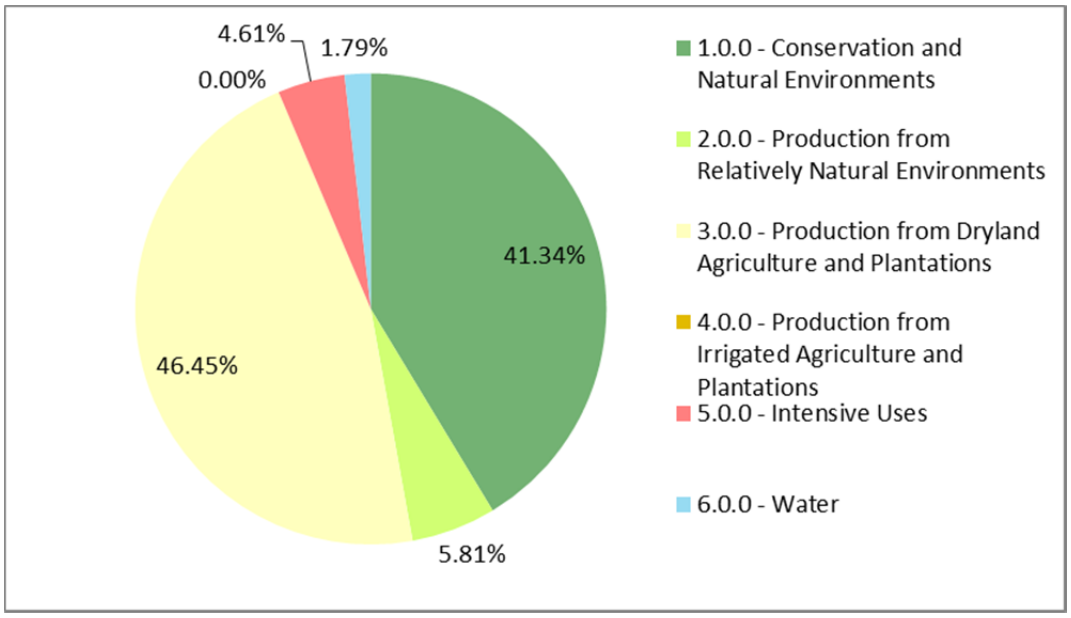


Figure I 1-92 Land use in the Mongarlowe River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Mongarlowe River sub-catchment were chiefly sourced from the SCA macroinvertebrate monitoring program with one additional site, sampled only in 2007, provided by OEH. The results are summarised in Figure I 1-93, Figure I 1-95 and Table I 1-52.

Data on macroinvertebrates in the Mongarlowe River sub-catchment was available from 11 sites, four of which had riffle sample sites. AUSRIVAS results for a total of 57 samples was provided however the twos samples from R13 in 2011 were outside the experience of the AUSRIVAS model.

Two core sites, Mong1 and R13, both maintained edge and riffle habitat and have been sampled and assessed consistently since 2001. The previous audit findings presented results of AUSRIVAS analysis which assessed the sites to be consistently reference condition (band A), with only a few exceptions. Results of the current audit period have shown a decline in condition from 2010 at both long-term monitoring sites and a decline in macroinvertebrate community data from the previous audit period (Figure I 1-94). The latest AUSRIVAS ratings were severely

impaired (band B) and significantly impaired (band B) for both habitats at Mong1 and R13 respectively. As with other southern catchment sites a large increase in median flows in the sub-catchment (Table I 1-53) may have influenced macroinvertebrate community data to some extent.

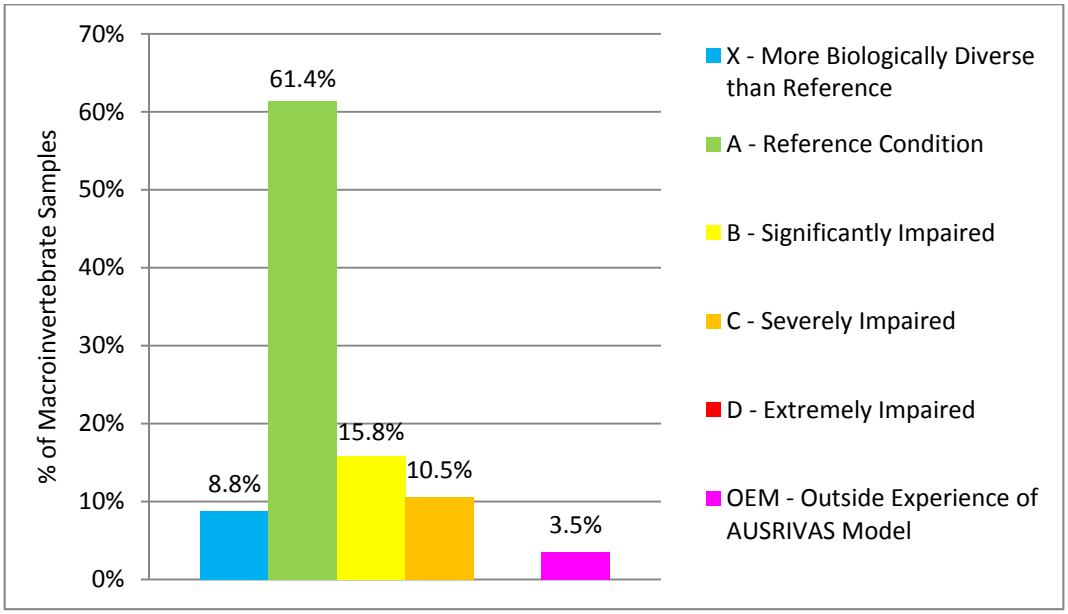


Figure I 1-93 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Mongarlowe River sub-catchment

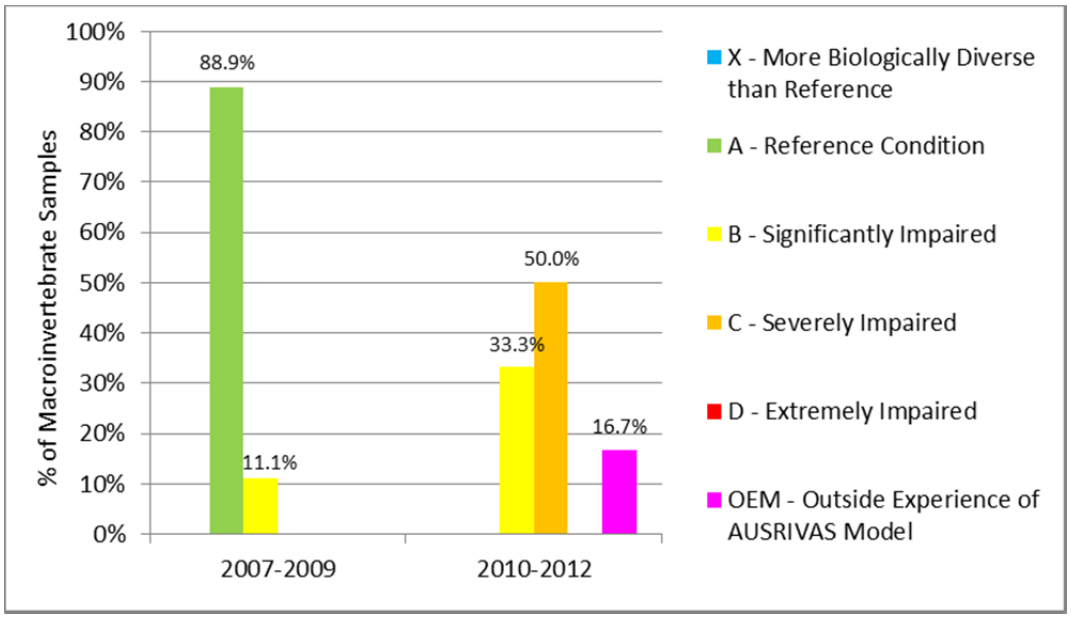
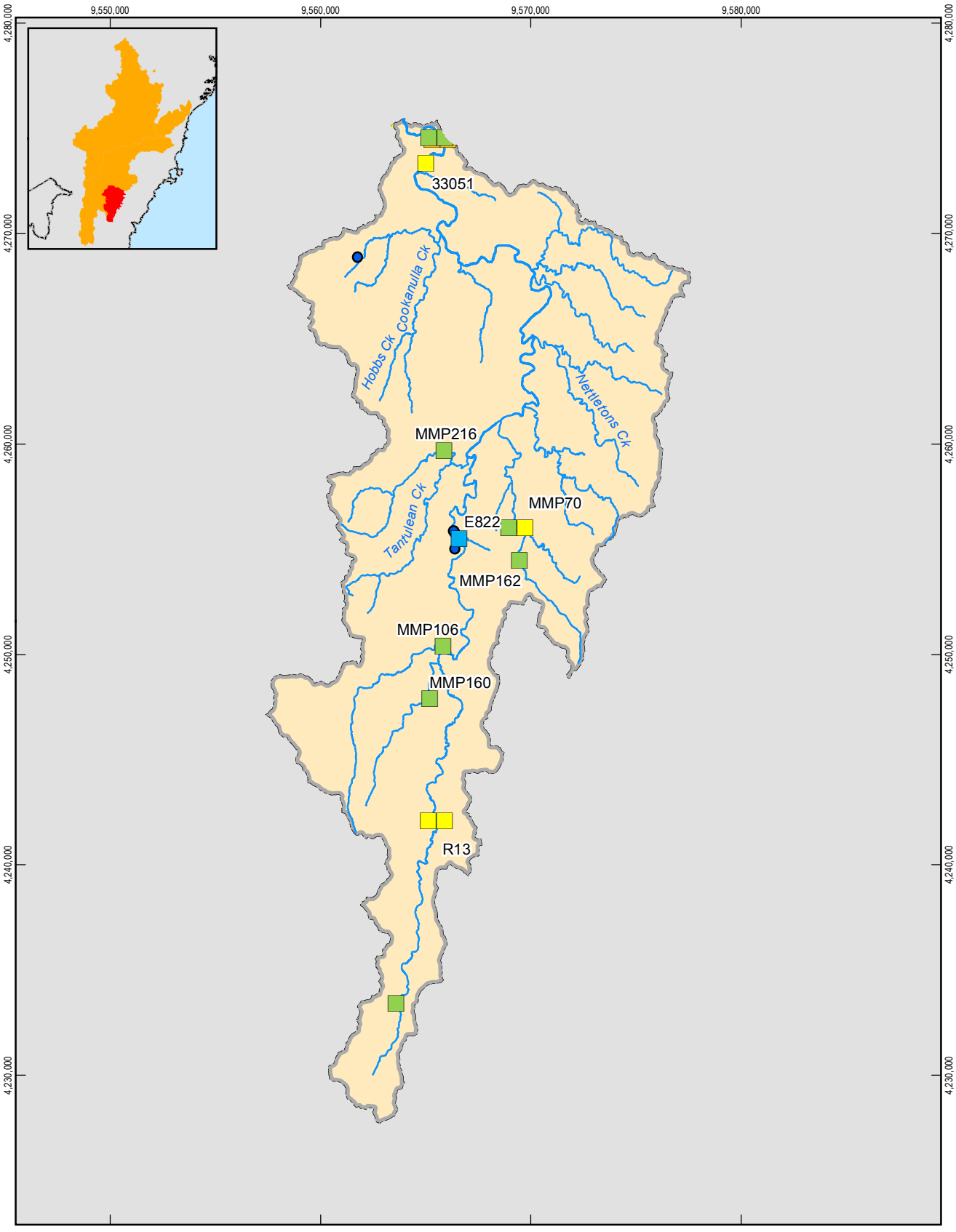


Figure I 1-94 Comparison of AUSRIVAS results from the Mongarlowe River sub-catchment: 2007-09 to 2010-12



LEGEND

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- D - Extremely Impaired
- OEM - Outside Experience of Model

Water Quality Monitoring Site

Waterbody

Waterway

Sub-catchment Boundary

Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Sydney Catchment Authority
Catchment Audit 2013

Mongarlowe River Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number	2314960
Revision	0
Date	26 Nov 2013

Figure I 1-95

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Table I 1-52 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Mongarlowe River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
33051	Edge	-35.26146	149.91371								B					
E822	Edge	-35.421944	149.936389			X										
MMP106	Edge	-35.46824	149.92973					A								
MMP160	Edge	-35.49094	149.92353						A							
MMP162	Edge	-35.43035	149.96843							A						
MMP216	Edge	-35.38436	149.92733								A					
MMP272	Edge	-35.6218	149.9105									A				
MMP70	Edge	-35.41651	149.96741				A									
MMP70	Riffle	-35.41651	149.96741				B									
Mong1	Edge	-35.25123	149.92169		A	A	A	A	A	B	A	A	A	C	C	C
Mong1	Riffle	-35.25123	149.92169				B	A	A	A	A	A	A	C	C	C
R13	Edge	-35.54308	149.92974		X	A	X	A	A	A	A	A	A	B	OEM	B
R13	Riffle	-35.54308	149.92974				A	X		A	A	B	A	B	OEM	B
SHOA1211	Edge	-35.25042	149.91998							X	A		A			
SHOA1211	Riffle	-35.25042	149.91998							A	A					

Water availability

Surface Water Flow

Flow data from two gauges within the Mongarlowe River sub-catchment was considered under this current audit. The assessment of these gauges is consistent with previous audits. Table I 1-53 identifies the gauges assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-53 Flow (ML/day) at gauging stations in the Mongarlowe River sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
215007	Mongarlowe River at Monga	02/01/1950[1]	16.08	7.48	12.17	13.15	34.43
215210	Mongarlowe River at Mongarlowe	08/11/1993	50.67	22.84	18.30	21.94	52.49

Notes:

1. All discharge data has been used for the Mongarlowe at Monga Gauging Station. There are a few years, from 1950-1952, when flow at this site was measured. There was then a large gap in records between 1952 and when records started again in 2004.

The Mongarlowe River at Monga gauging station (monitor 215007) dates to 1950, but was shut down in 1952 and did not recommence measurements until 2004. Only the 2004+ records have been used in this assessment, as the 1950-1952 period is not considered a long enough period to have statistical significance. Flows in Mongarlowe River at Monga were higher during the audit period (median flow 34.3 ML/day) than for the long-term average over the full 9 years of available gauging data (median flow 16.1 ML/day). Flows in the audit period were higher than average over the whole flow exceedance spectrum.

The Mongarlowe River at Mongarlowe gauge (monitor 215210) is downstream of, and has a longer continuous record than the Monga gauge. Median flows during the audit period were approximately equal to the long-term median (52.5 ML/day vs 50.5 ML/day), with both low and high flows occurring slightly less frequently than the long-term average.

Catchment water quality

Long-term water quality monitoring in the Mongarlowe River sub-catchment is undertaken by the SCA on the Mongarlowe River at Mongarlowe (E822). However, the long term monitoring of E822 has been discontinued and no data is available for the current audit period. Despite this, long-term trend analyses based on all available data have been carried out in this audit. Based on the long-term data no significant trend was detected for TN. An increasing long-term trend was detected for TP but this was only minor with concentrations increasing by 0.001 mg/L per year. Electrical conductivity was also found to be increasing overtime but this was again only minor with concentrations increasing by <0.001 mS/cm per year. There was no significant long-term trend detected for chlorophyll à.

Storage water quality

No long-term water quality monitoring data for storages in the Mongarlowe River sub-catchment was made available to the auditor for the 2010-13 audit period.

1.25 Braidwood Creek

1.25.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Braidwood Creek sub-catchment are shown in Figure I 1-96.

The Braid Wood Creek sub-catchment is primarily used for Production from Dryland Agriculture and Plantations (62%) and land is chiefly utilised for Grazing modified pastures (59.2%) with some Plantation forestry (1.4%) and Land in transition (1.3%). Conservation and Natural Environments (23.9%) is the second most extensive land use class in the Braidwood sub-catchment and this is primarily due to land used for Other minimal use (16.3%) and Nature conservation (7.4%). Production forestry (8.8%) is also a key land use within the sub-catchment and Residential and farm infrastructure (3.1%) makes up a considerable proportion of the Intensive Uses (4.0%) land use class.

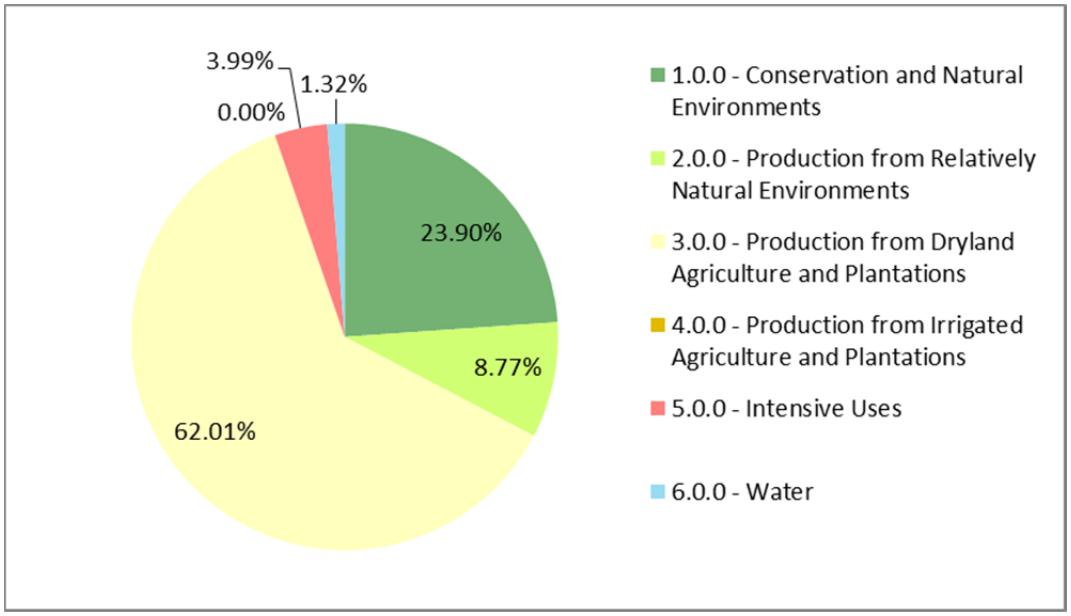


Figure I 1-96 Land use in the Braidwood Creek sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Braidwood Creek sub-catchment were primarily sourced from the SCA macroinvertebrate monitoring program, and data for two historic sites and one additional monitoring site, sampled only in 2007, were provided by OEH. The results are summarised in Figure I 1-97, Figure I 1-99 and Table I 1-54.

Results of AUSRIVAS analysis was available for 12 sites with riffle habitat occurring at just three of these which suggests riffle habitat is uncommon in this sub-catchment. Results for a total of 41 samples were provided.

Considering all samples significantly impaired (band B) was the most frequent AUSRIVAS result (48.8%). This was closely followed by reference condition (band A) (43.9%), sites assessed as more biologically diverse than reference (band X) (4.9%) and severely impaired (2.4%). Overall the sub-catchment could be considered to be in a in a slightly degraded condition.

Two core sites, E860 and E891 had been sample and assessed each year from 2001 to 2009 but only E860 was sampled in the current audit period. AUSRIVAS scores at E860 have been

predominately reference condition (band A) but observed a decline to significantly impaired (band B) in 2010, for both riffle and edge habitats, then recovered tor reference condition in the subsequent two years. MMP62 was the only other site to be sampled during this audit period and was rated significantly impaired (band B), similar to the score it received prior in 2004.

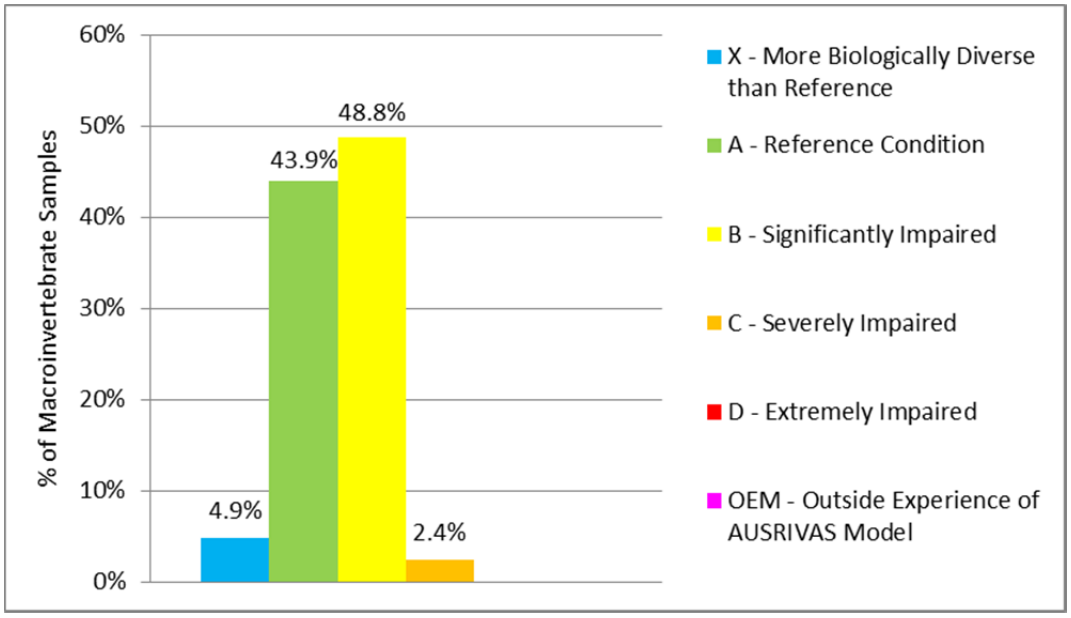


Figure I 1-97 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Braidwood Creek sub-catchment

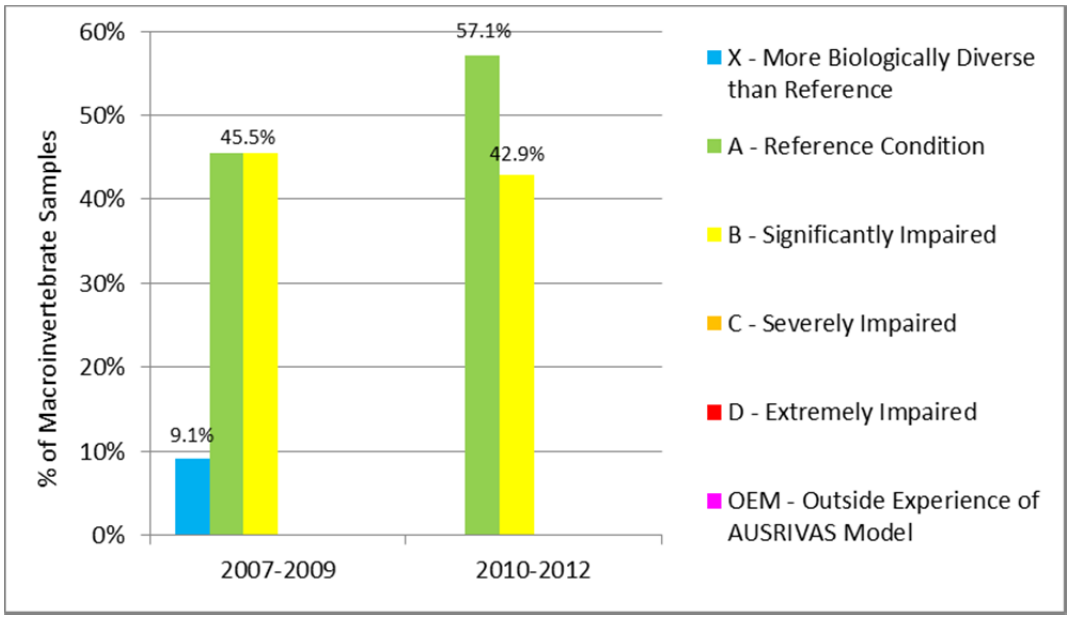
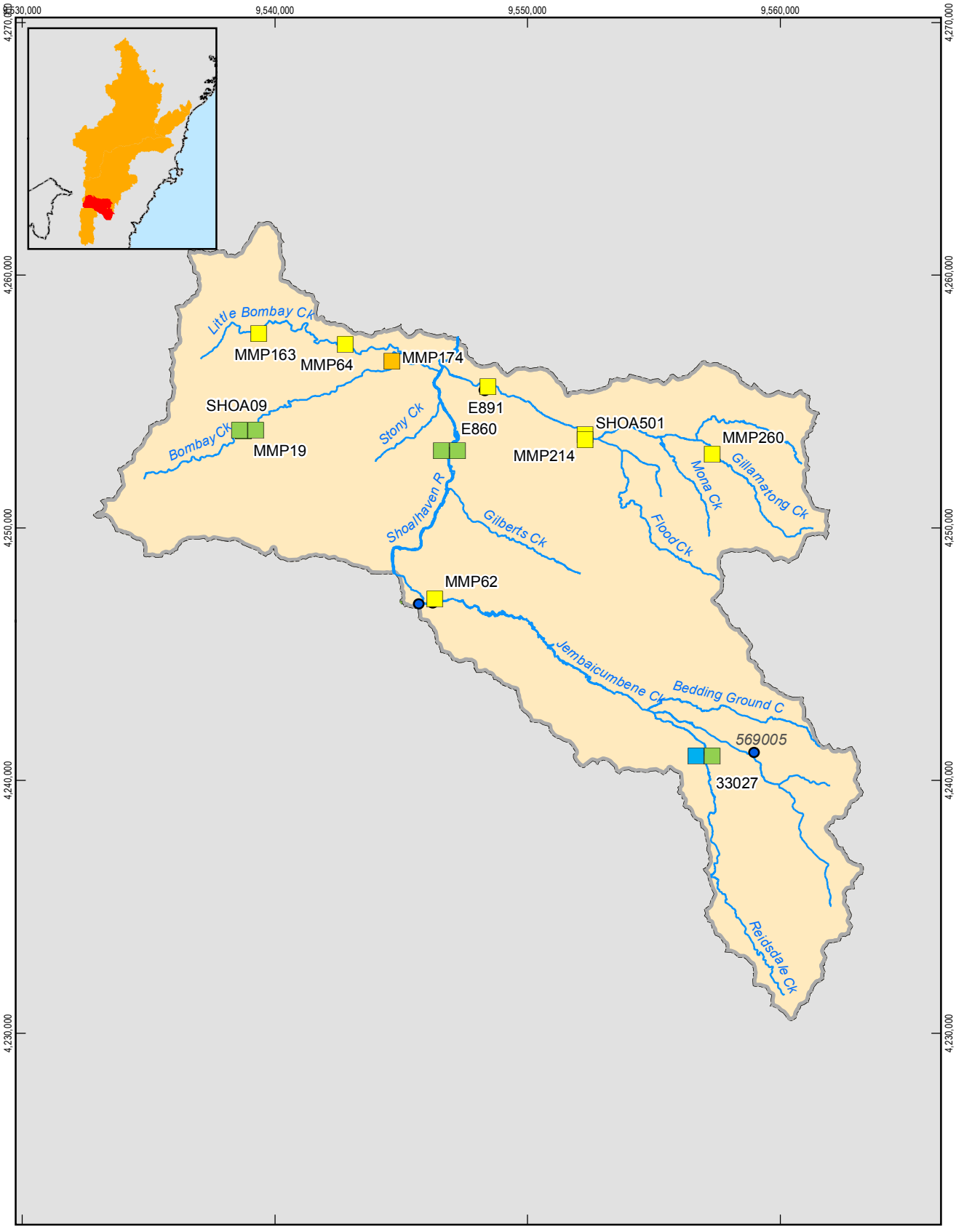


Figure I 1-98 Comparison of AUSRIVAS results from the Braidwood Creek sub-catchment: 2007-09 to 2010-12



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model
- *Water Quality Monitoring Site*
- Waterbody
- Waterway
- Sub-catchment Boundary
- Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Sydney Catchment Authority
Catchment Audit 2013

Braidwood Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number	2314960
Revision	0
Date	26 Nov 2013

Figure I 1-99

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Table I 1-54 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Braidwood Creek sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
33027	Edge	-35.55507	149.83591								X					
33027	Riffle	-35.55507	149.83591								A					
E860	Edge	-35.44879	149.72117		A	X	A	A	B	A	A	A	A	B	A	A
E860	Riffle	-35.44879	149.72117				B	A			A			B	A	A
E891	Edge	-35.42568	149.73655		B	B	B	B	B	B	B	B	B			
MMP163	Edge	-35.40881	149.63604						B							
MMP174	Edge	-35.41745	149.69444							C						
MMP19	Edge	-35.44365	149.63054			A										
MMP214	Edge	-35.44186	149.77951								B					
MMP260	Edge	-35.44748	149.83522									B				
MMP62	Edge	-35.50167	149.71583				A	B								B
MMP64	Edge	-35.41167	149.67389				B									
SHOA09	Edge	-35.4433	149.6331	A												
SHOA09	Riffle	-35.4433	149.6331	A												
SHOA501	Edge	-35.4436	149.7796	B												

Water availability

Surface water flow

Flow data from three gauges within the Braidwood Creek sub-catchment was considered under this current audit. The assessment of these gauges is consistent with previous audits. Table I 1-55 identifies the gauges assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-55 Flow (ML/day) at gauging stations in the Braidwood Creek sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
215237	Gillamatong Creek	13/03/1994	3.11	2.28	1.85	2.83	11.74
215241	Shoalhaven River at Bendoura	29/08/1994	11.89	9.77	3.66	5.93	18.89
215209	Shoalhaven River at Mountview	08/11/1973	153.20	68.55	33.40	50.91	204.54

In general, flows during the audit period in the Braidwood Creek sub-catchment were higher than both the previous audit period and the long-term average.

Flows in Gillamatong Creek (monitor 215237) during the audit period were significantly higher than the long-term average and the previous audit period across the full range of low to high flows. The median flow during the audit period was 11.74 ML/day compared to the long-term median of 3.11 ML/day. Gillamatong Creek receives flows from the Braidwood STP.

Flows in the Shoalhaven River at Bendoura gauge (monitor 215241) were higher during the audit period than the long-term records over the entire flow exceedance curve (median flow 18.9 ML/day vs 11.9 ML/day). High (10% exceedance) and low (90% exceedance) flows were also significantly higher than the long-term averages, by approximately 200% and 400% respectively. According to metadata provided by SCA with the flow gauge data, this gauge is actually situated on Jembaicumbene Creek, not the Shoalhaven River - this accounts for the discrepancy when compared with upstream (215008) and downstream (215209) gauges on the Shoalhaven River.

Flows in the Shoalhaven River at Mountview gauge (monitor 215209) during the audit period were slightly higher than long-term averages in the median to high-flow exceedance ranges, although low flows were significantly higher than long-term averages. Flows during the previous audit period were less than half the long-term averages over the full flow exceedance curve.

Catchment water quality

Long-term water quality monitoring in the Braidwood sub-catchment is available from the SCA's long-term river water quality monitoring site on Gillamatong Creek at Braidwood (E891) and the Shoalhaven River at Mount View (E860). However, the long term monitoring of E891 has been discontinued and no data were available for the current audit period. Despite this, long term trend analyses, based on all available data, were carried out in this audit.

E891 - Gillamatong Creek at Braidwood

- The previous audit (DECCW, 2010b) found the median TN level in Gillamatong Creek at Braidwood to be high (0.63 mg/L) during 2007-10, and most TN levels measured in Gillamatong Creek at Braidwood were above the ANZECC Guideline for upland rivers. The median TN levels during the previous two periods (2001-2004 and 2004-2007) were 0.45 and 0.6 mg/L, respectively.
- The median TP level in Gillamatong Creek at Braidwood was high (0.091 mg/L) during the 2007-10, and was above the ANZECC Guideline for upland rivers. The median TP levels during the previous two periods (2001-2004 and 2004-2007) were 0.027 and 0.03 mg/L, respectively.
- During the current audit, based on the long term data, a significant increasing trend was detected for TN and TP with concentrations increasing by 0.016 and 0.003 mg/L per year.
- The median conductivity level in Gillamatong Creek at Braidwood was relatively high (0.384 mS/cm) during the 2007-10 audit period, and was above the ANZECC Guideline for upland rivers. This median was higher than the 2001-2004 period (0.284 mS/cm), but lower than the 2004-2007 period (0.465 mS/cm).
- In the current audit period, electrical conductivity was found to be decreasing overtime by 0.023 mS/cm per year.
- There was no significant temporal trend detected for chlorophyll à.

E860 - Shoalhaven River at Mount View

- The median TN concentration for E860 was 0.550 mg/L during the current audit; 77% of recordings exceeded the ANZECC guideline for upland rivers. The median TN concentration during the current audit was higher than previous audits (median values for previous five audits ranged from 0.275 to 0.540 mg/L). A significant long-term trend was detected for TN with concentrations decreasing by 0.006 mg/L per year.
- During the current audit the median TP concentration for E860 was 0.061 mg/L; 88% of recordings above the ANZECC guideline for upland rivers. The median TP concentration during the current audit was higher than previous audits (median values for previous five audits ranged from 0.010 to 0.036 mg/L). A significant long-term trend was detected for TP with concentrations increasing by 0.002 mg/L per year.
- The median electrical conductivity for E860 was 0.090 mS/cm during the current audit; no recordings exceeding the ANZECC guideline for upland rivers. The median conductivity during the current audit was within the range of values recorded in other audits (median values for previous five audits ranged from 0.076 to 0.094 mS/cm). There was a significant long-term trend detected for conductivity at E861 with concentrations decreasing by 0.002 mS/cm per year.
- The median chlorophyll à concentration for E860 was 1.8 µg/L during the current audit; 2% of recordings exceeded the ANZECC guideline for freshwater lakes and reservoirs. The median chlorophyll à concentration during the current audit was within the range of values recorded in previous audits (median values for previous five audits ranged from 0.5 to 2.2 µg/L). A significant long-term trend was detected for chlorophyll à with concentrations decreasing by 0.07 µg/L during

Storage water quality

No long-term water quality monitoring data for storages in the Braidwood Creek sub-catchment was made available to the auditor for the 2010-13 audit period.

1.26 Back and Round Mountain Creeks

1.26.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Back and Round Mountain Creeks sub-catchment are shown in Figure I 1-100.

Similar to many of the southern sub-catchments land use in the Back and Round sub-catchment was predominantly Production for Dryland Agriculture and Plantations (61.6%) most of which was attributed to the tertiary class of Grazing modified pastures (49.4%) and Plantation Forestry (11.5%). Other key land uses in the sub-catchment included Conservation and Natural Environments (19.1%) and Production (forestry) from Relatively Natural Environments (17.3%).

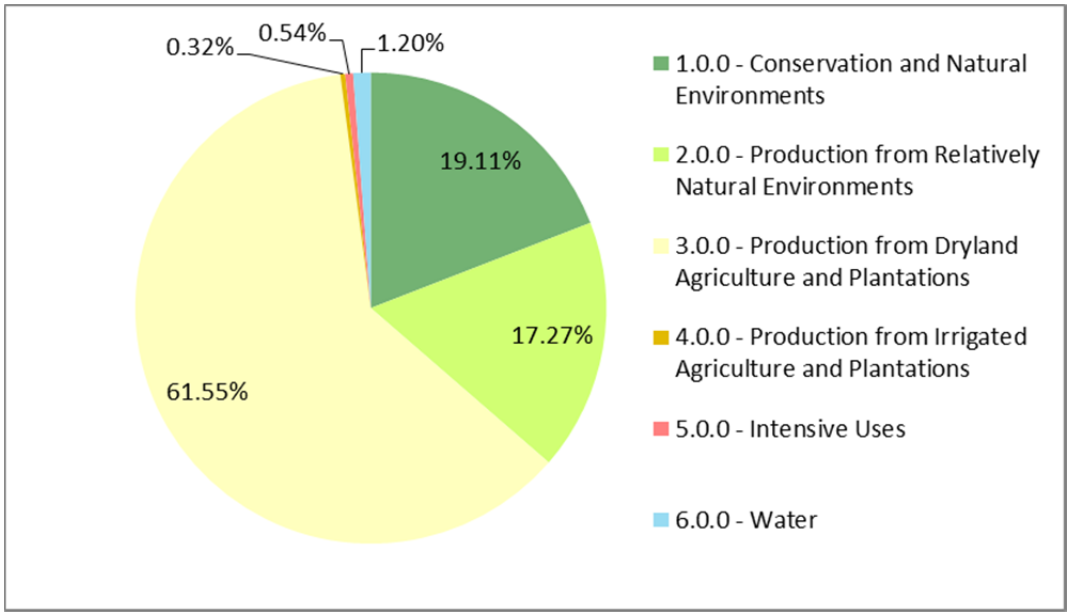


Figure I 1-100 Land use in the Back and Mountain Creeks sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Back and Round Mountain Creeks sub-catchment were mainly sourced from the SCA macroinvertebrate monitoring program and data for three sites provided by OEH. The results are summarised in Figure I 1-101, Figure I 1-103 and Table I 1-56.

AUSRIVAS results for 11 sites was provided with riffle habitat occurring at just three sites and data for a total of 26 samples were provided for analysis. Considering all available AUSRIVAS results the majority were assessed as significantly impaired (band B)(53.8%), followed by reference condition (band A) (43.2%) and one sample was assessed as more biologically diverse than reference (band X).

The previous audit stated that “two core sites, MMP16 and MMP17 (both with edge and riffle habitat) had been assessed each year since 2001” however limited data for these sites was presented in the tables and figures. These sites have been consistently sampled since 2009 ad were the only sites in the Back and Round Mountain Creeks sub-catchment for which AUSRIVAS results were provided. Both sites have been predominantly rates as significantly impaired (band B) which was also their result in the 2012 data.

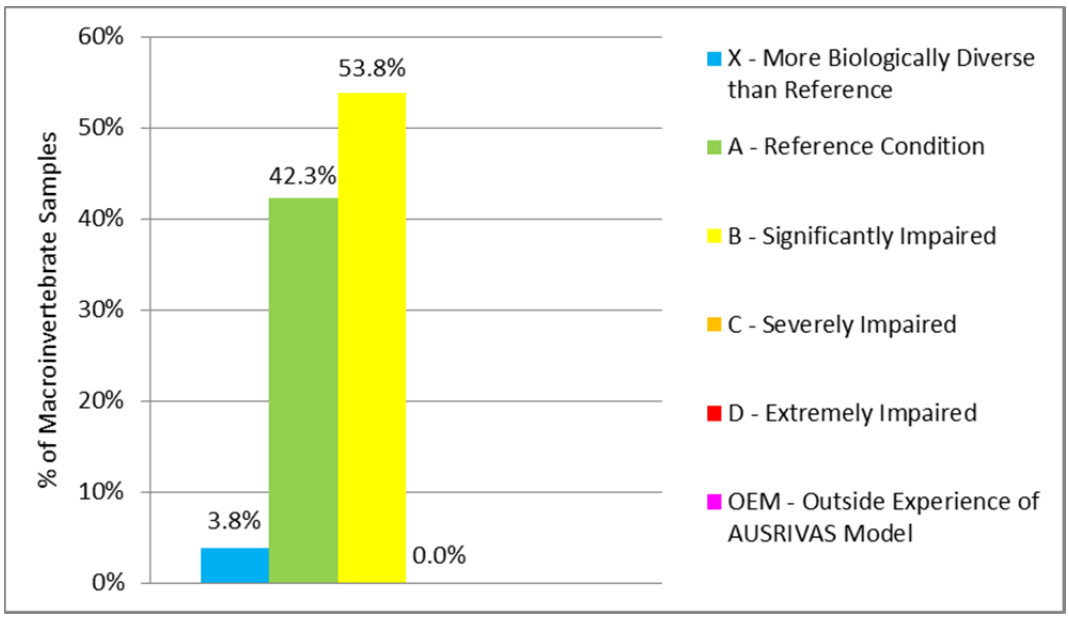


Figure I 1-101 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Back and Round Mountain Creeks sub-catchment

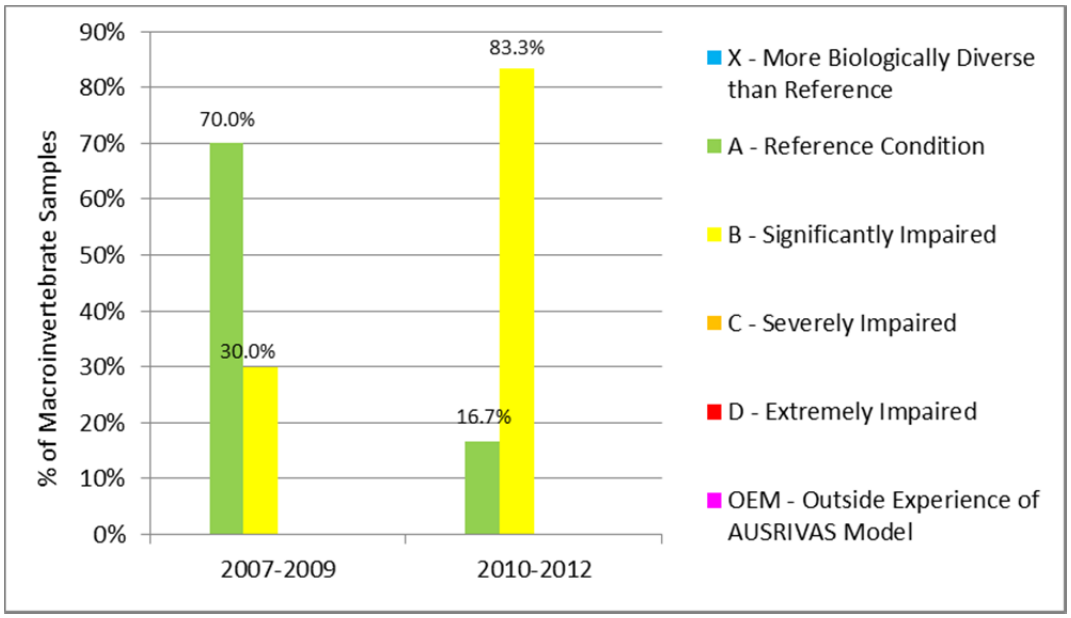
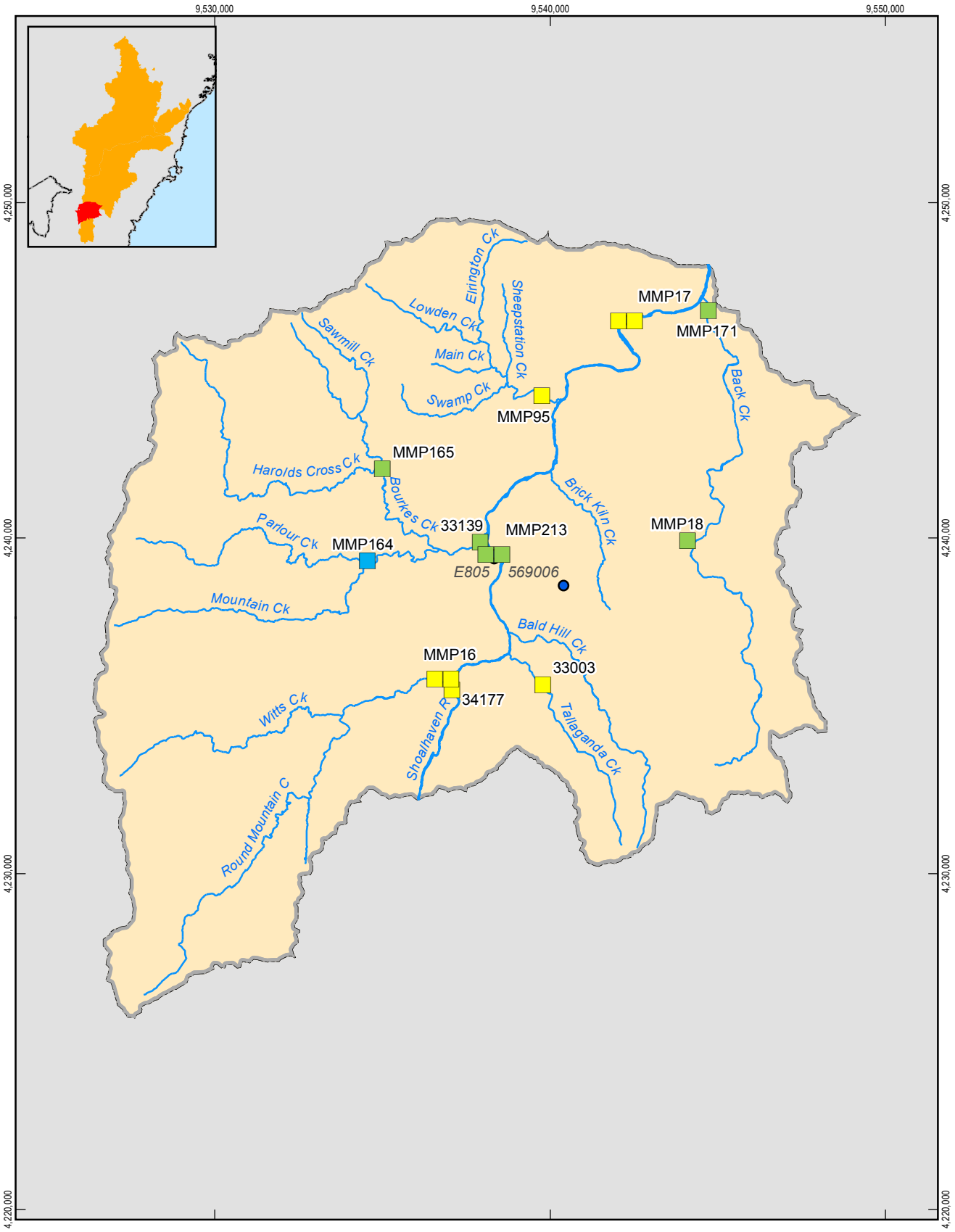


Figure I 1-102 Comparison of AUSRIVAS results from the Back and Round Mountain Creeks sub-catchment: 2007-09 to 2010-12



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model

Water Quality Monitoring Site

Waterbody

Waterway

Sub-catchment Boundary

Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Sydney Catchment Authority
Catchment Audit 2013

Back & Round Mountain Creeks Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number 2314960
Revision 0
Date 26 Nov 2013

Figure I 1-103

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Table I 1-56 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Back and Round Mountain Creek sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
33003	Edge	-35.6074	149.64688								B					
33139	Edge	-35.5695	149.62516										A			
34177	Edge	-35.60938	149.61703										B			
MMP16	Edge	-35.60659	149.61447										A	B	B	B
MMP16	Riffle	-35.60659	149.61447										A	B	B	B
MMP164	Edge	-35.57534	149.58817						X							
MMP165	Edge	-35.55053	149.5924									A				
MMP17	Edge	-35.50914	149.67196										B	B	A	B
MMP17	Riffle	-35.50914	149.67196										A	B	A	B
MMP171	Edge	-35.50575	149.69823							A						
MMP18	Edge	-35.5678	149.69332			A										
MMP213	Edge	-35.57284	149.63031								A					
MMP213	Riffle	-35.57284	149.63031								A					
MMP95	Edge	-35.52979	149.64419					B								

Water availability

Surface water flow

No recent (or historic) flow data were available from the Back and Round Mountain Creeks sub-catchment.

Catchment and storage water quality

Not available.

1.27 Jerrabattgulla Creek

1.27.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Jerrabattgulla Creek sub-catchment are shown in Figure I 1-104.

Production from Dryland Agriculture and Plantations (45.2%) was the primary land use and this was chiefly attributed to Grazing modified pastures (42.8%). Conservation and Natural Environments (29.1%) was the second most extensive land use within the sub-catchment and this was split between the tertiary classes of Nature conservation (14%) and Other minimal use (15.1%). Production (forestry) from Relatively Natural Environments(24%) also contributed a major proportion of the landuse within the sub-catchment.

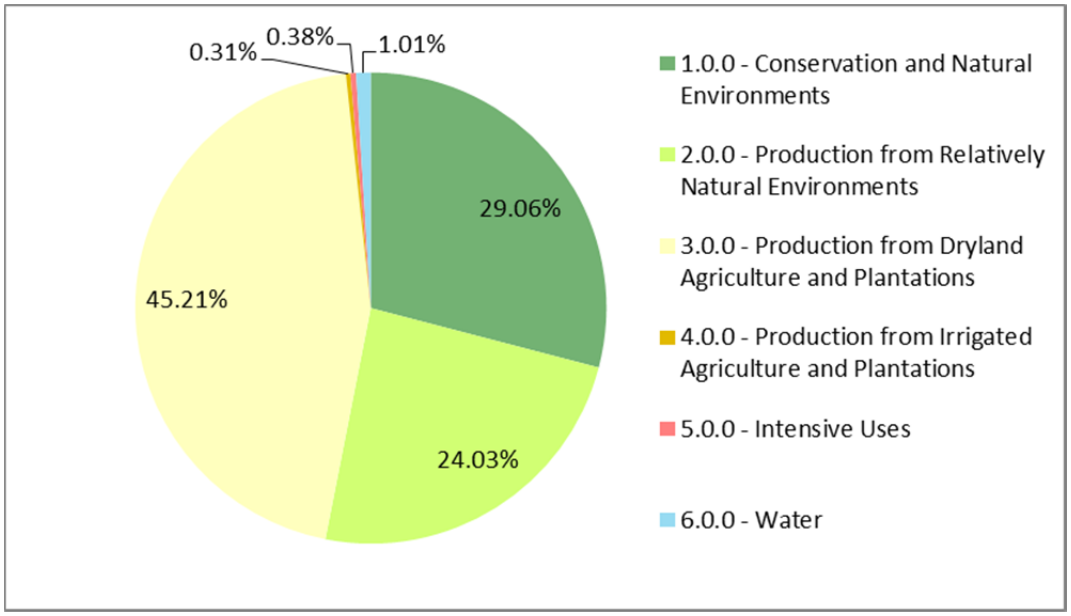


Figure I 1-104 Land use in the Jerrabattgulla Creek sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Jerrabattgulla Creek sub-catchment were sourced from the SCA macroinvertebrate monitoring program and data provided by OEH. The results are summarised in Figure I 1-105, Figure I 1-107 and Table I 1-57.

Data on macroinvertebrates in the Jerrabattgulla Creek sub-catchment was available from 16 sites however the majority of these samples were collected from two core long-term monitoring sites including MMP08 and MMP09. Data was provided for a total of 41 samples, only two of which were collected from rifle habitats, and one which was outside the experience of the AUSRIVAS model.

The majority of samples were assessed to be reference condition (band A) (56.1%), with the remaining samples being assessed as significantly impaired (band B) (24.4%), more biologically diverse than reference (band X) (9.8%).

Data for edge habitat only was provided for the two core sites were and both have been consistently sampled and assessed since 2002. Up until 2010 AUSRIVAS scores at both core sites had consistently been reference condition (band A) or better but samples from 2010 to

2012 suggest a decline in condition at the sites as samples were rated significantly impaired (band B) or severely impaired (band C).

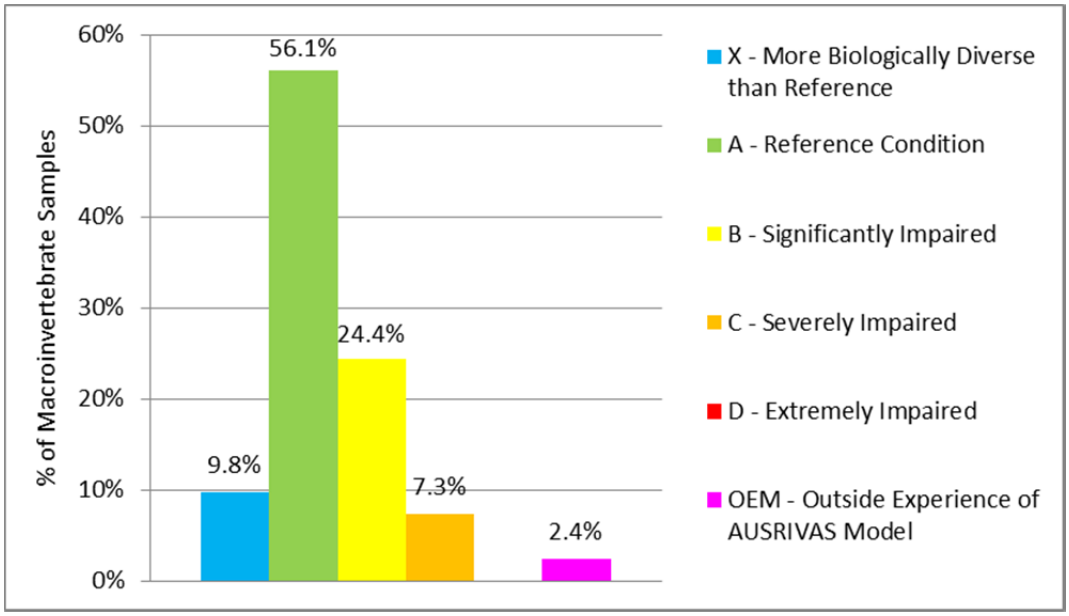


Figure I 1-105 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Jerrabattgulla Creek sub-catchment

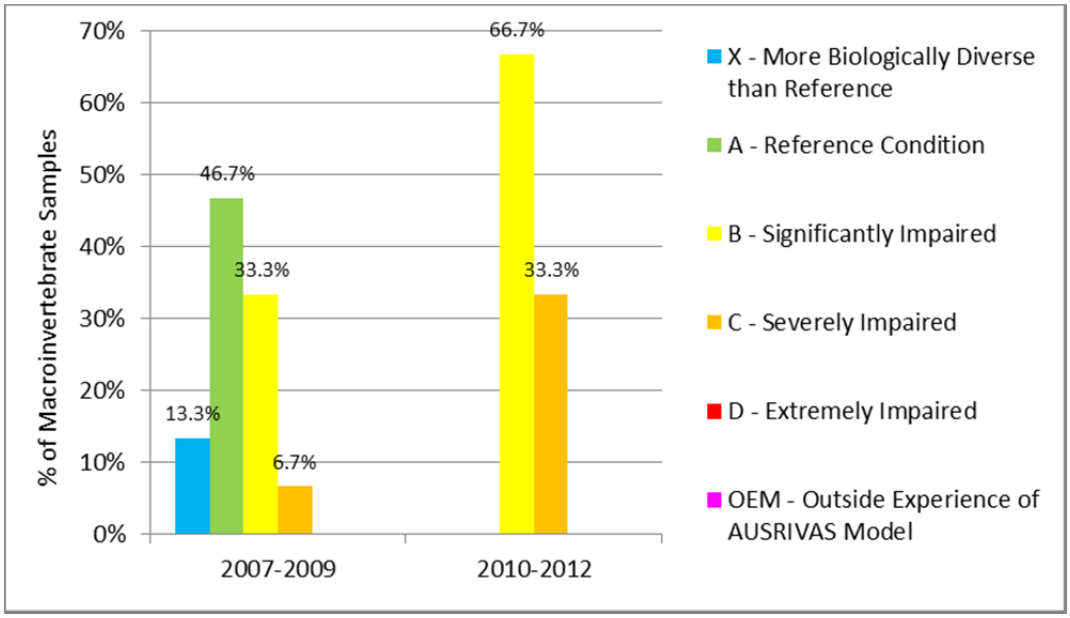
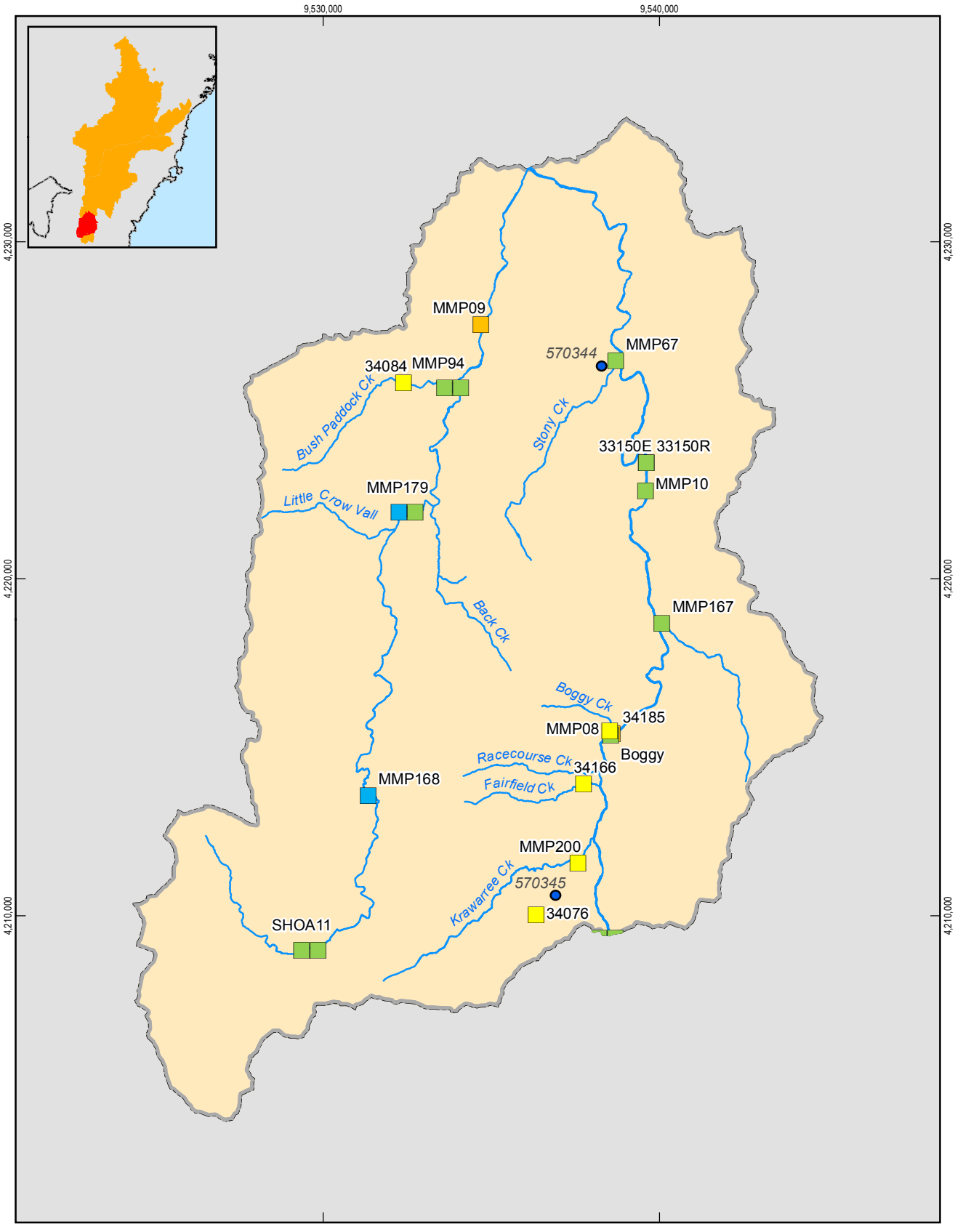


Figure I 1-106 Comparison of AUSRIVAS results from the Jerrabattgulla Creek sub-catchment: 2007-09 to 2010-12



LEGEND

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0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
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Sydney Catchment Authority
Catchment Audit 2013

Jerrabattagulla Creek Sub-catchment
Macroinvertebrate and Water Quality Monitoring Sites

Job Number	2314960
Revision	0
Date	26 Nov 2013

Figure I 1-107

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Level 6, 20 Smith Street Parramatta NSW 2150 Australia T 61 2 8898 8800 F 61 2 8898 8810 E ptamail@ghd.com W www.ghd.com

Data source: © Commonwealth of Australia (Geoscience Australia): 250K Topo Data (2007); SCA: Boundaries (2013), AUSRIVAS results (2013). Created by: AD

Table I 1-57 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Jerrabattgulla Creek sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
34076	Edge	-35.83901	149.61601								B					
34084	Edge	-35.69757	149.56818								B					
34166	Edge	-35.80365	149.63049										B			
34185	Edge	-35.78995	149.63952										C			
33150E	Edge	-35.71736	149.64839										A			
33150R	Edge	-35.71736	149.64839										A			
Boggy	Edge	-35.79039	149.63903		A											
MMP08	Edge	-35.78929	149.63869			A	A	A	A	OEM	A	B	A	B	B	B
MMP09	Edge	-35.6814	149.593		A	A	B	X	A	A	A	A	X	C	B	C
MMP10	Edge	-35.72485	149.64837			A										
MMP167	Edge	-35.76014	149.65486							A						
MMP168	Edge	-35.80817	149.55977						X							
MMP179	Edge	-35.73209	149.57083								X					
MMP179	Riffle	-35.73209	149.57083								A					
MMP200	Edge	-35.82488	149.62933									B				
MMP67	Edge	-35.69028	149.6375				A									
MMP94	Edge	-35.69861	149.58485					A								
MMP94	Riffle	-35.69861	149.58485					A								
SHOA11	Edge	-35.8499	149.5424	A												
SHOA11	Riffle	-35.8499	149.5424	A												

Water availability

Surface water flow

Flow data from one gauge within the Jerrabattgulla sub-catchment was considered under this current audit. The assessment of this gauge is consistent with previous audits. Table I 1-58 identifies the gauge assessed in this sub-catchment and provides a summary of the monitored flows during the current audit period, past audit periods and also the long term trend.

Table I 1-58 Flow (ML/day) at gauging stations in the Jerrabattgulla sub-catchment

Station number	Site name	Date records commenced	Long Term median	2001-2004 median	2004-2007 median	2007-2010 median	2010-2013 median
215008	Shoalhaven River at Kadona	18/09/1950	46.43	24.84	17.47	20.73	101.71

Flows in the Shoalhaven River at Kadona during the current audit period were higher than (approximately double) the long-term average (median 107 ML/day vs. long-term median 47 ML/day) and significantly higher (approximately 400%) than the last three audit periods over the whole flow exceedance range. This reflects the trend for higher-than-normal flows in the audit period for all Shoalhaven River gauges.

Catchment and storage water quality

Not available.

1.28 Upper Shoalhaven River

1.28.1 State of the catchment

Land use and Human settlements

The major ALUM7 land use classes in the Upper Shoalhaven River sub-catchment are shown in Figure I 1-108.

The dominant land use class in the sub-catchment was Conservation and Natural Environments (67.2%) and this was largely attributed to Nature conservation (61.4%) with some Other minimal use (5.8%). A large proportion of the land use was Production from Dryland Agriculture and Plantations (21.2%) which was chiefly Grazing modified pastures (21.1%) with very little Cropping (0.14%). Production (forestry) from Relatively Natural Environments (10.9%) accounted for the majority of the remaining land cover within the sub-catchment. Very small proportions of the land use were attributed to Water (0.29%) , Intensive Uses (0.19%), of which only 0.02% was Mining and 0.16% was Transport and communication.

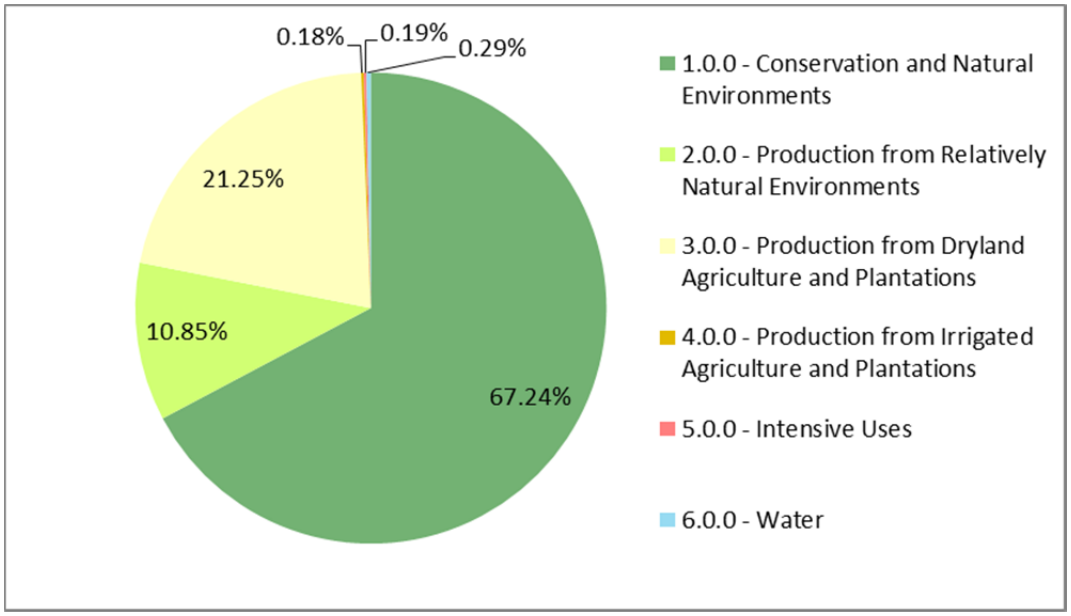


Figure I 1-108 Land use in the Upper Shoalhaven River sub-catchment

Biodiversity and habitats

Macroinvertebrates

Macroinvertebrate data for the Upper Shoalhaven River sub-catchment were sourced from the SCA macroinvertebrate monitoring program and data provided by OEH. The results are summarised in Figure I 1-109, Figure I 1-111 and Table I 1-59.

AUSRIVAS results for a 12 sites was provided from the Upper Shoalhaven River sub-catchment, eight of which had riffle habitat which suggests that riffle is a relatively common habitat in the sub-catchment. AUSRIVAS results for a total of 66 samples was available for analysis and the majority of these samples were rated as reference condition (band A) (51.5%). A further 34.8% of samples were rated significantly impaired (band B) and the remaining samples were more biologically diverse than reference condition (band X) (12.1%) with very few samples rated severely impaired (band C) (1.5%).

Similar to other sub-catchments two core sites were consistently sampled and assessed since 2001 including MMP06 and R8, both of which maintained edge and riffle habitat.

AUSRIVAS scores for both core sites had generally fluctuated between reference condition (band A) and more biologically diverse than Reference (band X). As with the majority of southern catchment sites both these long-term monitoring sites observed a decline in AUSRIVAS rating in towards the end of the last audit period and were subsequently consistently rated as significantly impaired (band B). The AUSRIVAS ratings for MMP06 improved to reference condition (band A) for the latest sampling data (2012) however R6 remained significantly impaired (band B).

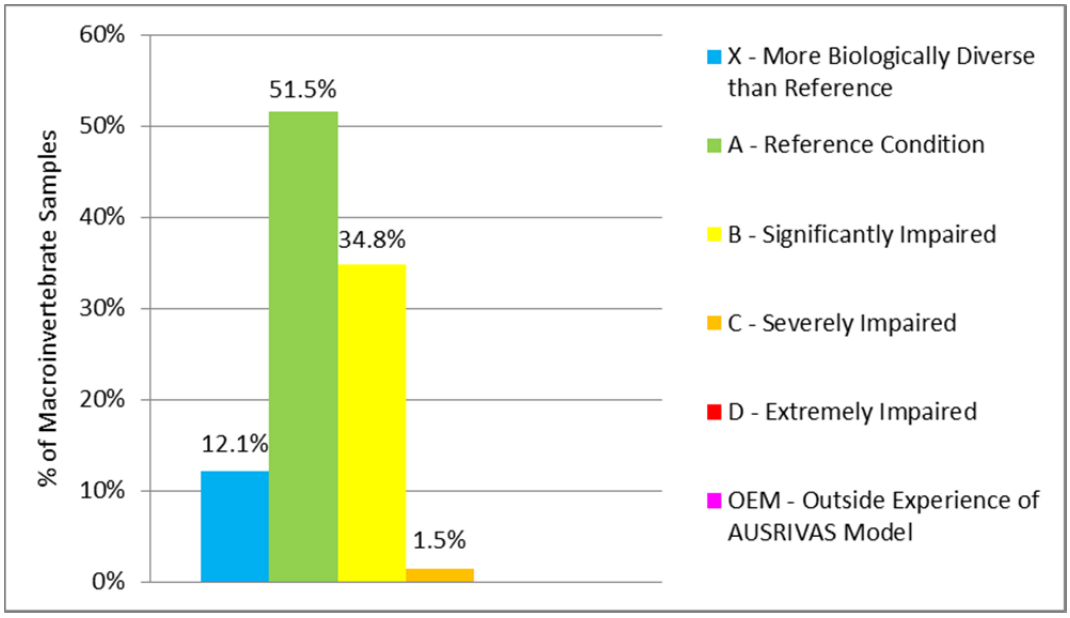


Figure I 1-109 Distribution of AUSRIVAS results for all macroinvertebrate sample data provided for the Upper Shoalhaven River sub-catchment

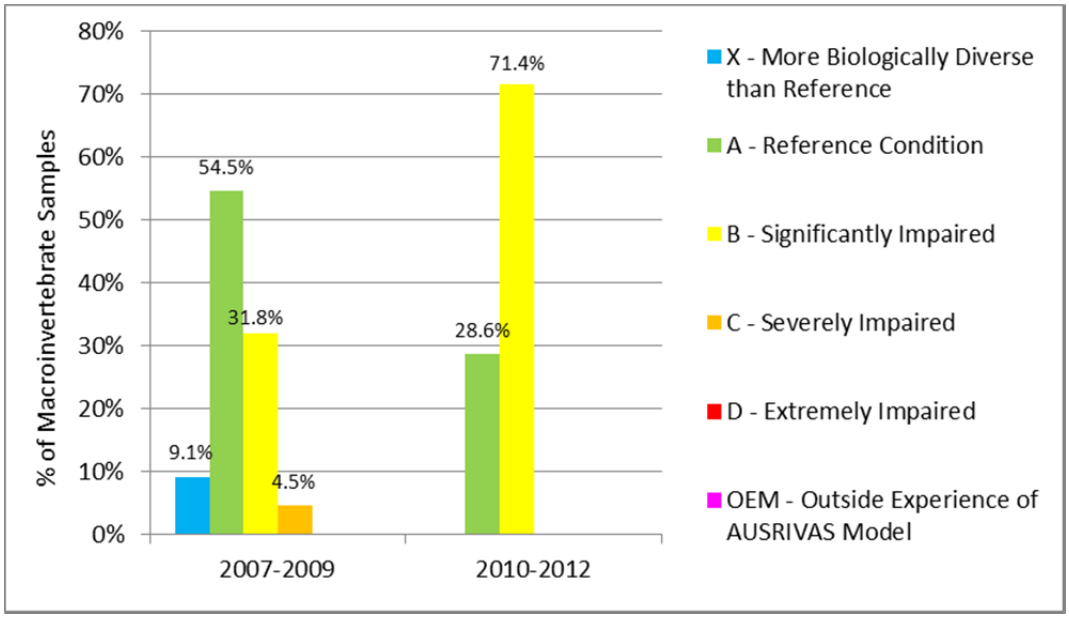
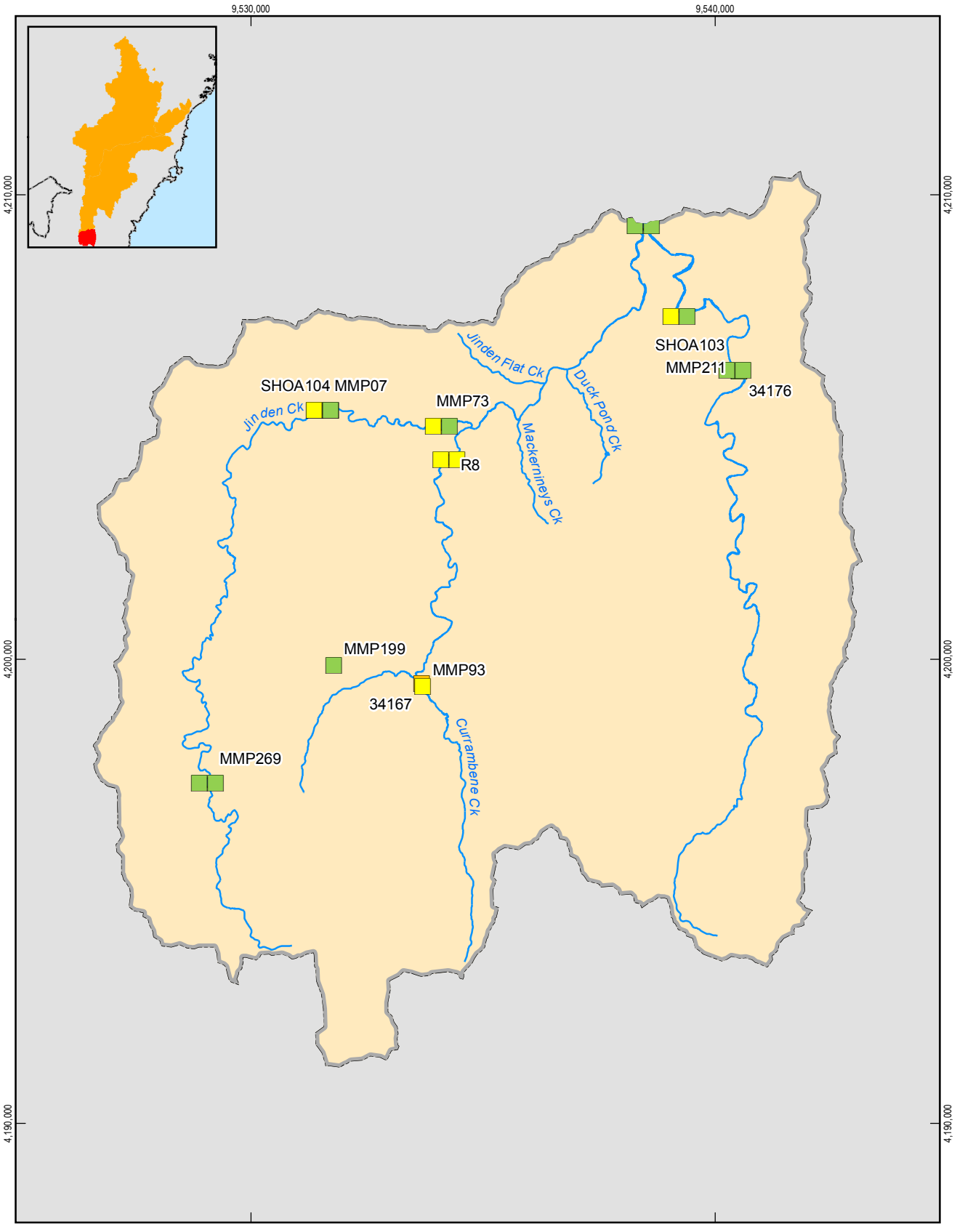


Figure I 1-110 Comparison of AUSRIVAS results from the Upper Shoalhaven River sub-catchment: 2007-09 to 2010-12



LEGEND

Macroinvertebrate Monitoring Sites AUSRIVAS Band and Description

- X - Richer than Reference
- A - Equal to Reference
- B - Significantly Impaired
- C - Severley Impaired
- D - Extremely Impaired
- OEM - Outside Experience of Model
- *Water Quality Monitoring Site*
- Waterbody
- Waterway
- Sub-catchment Boundary
- Focus Sub-catchment

Paper Size A4

0 1 2 3

Kilometres

Map Projection: Lambert Conformal Conic
Horizontal Datum: GDA 1994
Grid: GDA 1994 NSW lambert

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Upper Shoalhaven River Sub-catchment
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Figure I 1-111

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Table I 1-59 AUSRIVAS ranking of macroinvertebrate monitoring sites in the Upper Shoalhaven River sub-catchment

Site Code	Habitat	Latitude	Longitude	Historic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
34167	Edge	-35.93454	149.58939										C			
34176	Edge	-35.87238	149.66334										A			
MMP06	Edge	-35.84466	149.64001		X	X	A	X	X	A	A	A	B	B	B	A
MMP06	Riffle	-35.84466	149.64001				A	B		A	B	B	B	B	B	A
MMP07	Edge	-35.88195	149.56465			A			A							
MMP07	Riffle	-35.88195	149.56465						A							
MMP199	Edge	-35.9314	149.56833							A						
MMP211	Edge	-35.87223	149.66276								A					
MMP211	Riffle	-35.87223	149.66276								A					
MMP269	Edge	-35.9549	149.5393									A				A
MMP269	Riffle	-35.9549	149.5393									A				A
MMP73	Edge	-35.88444	149.59306				B									
MMP73	Riffle	-35.88444	149.59306				A									
MMP93	Edge	-35.93504	149.58967					B								
R8	Edge	-35.89098	149.59496		B	A	A	A	X	A	X	X	B	B	B	B
R8	Riffle	-35.89098	149.59496				B			A	A	A	B	B	B	B
SHOA103	Edge	-35.862	149.6491	B												
SHOA103	Riffle	-35.862	149.6491	A												
SHOA104	Edge	-35.88196	149.56457	A						A	A		B			
SHOA104	Riffle	-35.88196	149.56457	A						X	A		A			

Catchment water quality

Long-term water quality monitoring in the Upper Shoalhaven River sub-catchment was undertaken by the SCA at Bendoura (E809 – Jembaicumbene Creek). However, this site was discontinued as a routine water quality monitoring site in September 2001 and no data was available for the current audit period or the 2004-07 and 2007-10 audit periods.

- The median TN concentration for E809 during the final audit period that monitoring occurred was 0.65 mg/L and most recordings exceeded the ANZECC Guideline for upland rivers.
- The median TP concentration during the 2001-04 audit period was 0.043 mg/L and this value also exceeded the ANZECC Guideline for upland rivers. However, as indicated in the 2010 audit, there was only a limited sample size (N = 9) available for comparisons to the ANZECC Guidelines.
- The median electrical conductivity for E809 during 2001-04 was relatively low at 0.096 mS/cm and most recordings were below the ANZECC Guideline for upland rivers.
- The median chlorophyll à concentration during 2001-04 was also relatively low at 2.2 µg/L and this value was below the ANZECC Guideline for freshwater lakes and reservoirs.

Storage water quality

Not available.

GHD

133 Castlereagh St Sydney NSW 2000
-
T: +61 2 9239 7100 F: +61 2 9239 7199 E: sydmail@ghd.com.au

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Document Status

Rev No.	Authors	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
1	N. Chandrasena D. Baker M. Presswell S. Claus C. Ferguson			C. Ferguson		27/11/13

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