Water quality

Information Sheet

Aquatic ecosystem condition reports

2015 panel assessment of creeks and rivers from the Eyre Peninsula, South Australian Murray–Darling Basin and Adelaide and Mount Lofty Ranges NRM regions

Issued August 2016

EPA 1091/16: This information sheet describes the outcome of the panel assessment of creeks and rivers from the Eyre Peninsula, South Australian Murray–Darling Basin, and Adelaide and Mount Lofty Ranges NRM regions, sampled during autumn and spring 2015.

Introduction

The EPA coordinates a monitoring, evaluation and reporting (MER) program on the aquatic ecosystem condition of South Australian creeks and rivers. This MER program is designed to meet several objectives:

- Providing a statewide monitoring framework for creeks and rivers that revolves through the NRM regions with sufficient frequency to allow for state of the rnvironment reporting.
- Describing aquatic ecosystem condition for broad general public understanding.
- Identifying the key pressures and management responses.
- Providing a useful reporting format that supports environmental decision making within government, community and industry.

This information sheet summarises the scientific work used in assessing monitoring data from creeks and rivers. Aquatic ecosystem science is not always rigid and precise; it is often open to different interpretations in several respects. The EPA has decided that the best way to assess the condition of streams is through an expert panel deliberation that uses a consistent descriptive modelling approach. The panel members comprised an environmental consultant and two biologists from the EPA (the authors of this assessment). All have at least 15 years' experience in monitoring and assessing a range of streams across South Australia.

The panel members were:

- Peter Goonan, EPA
- Tracy Corbin, EPA
- Chris Madden, Freshwater Macroinvertebrates.

This information sheet is a technical document that contains relatively sophisticated concepts and content. It summarises the scientific assessment of data collected from creeks and rivers found in the Eyre Peninsula, South Australian Murray–Darling Basin and Adelaide and Mount Lofty Ranges NRM regions in 2015.

Site selection

A total of 41 sites were sampled during autumn and spring 2015, comprising 10 sites from Eyre Peninsula, 14 from the Eastern Mount Lofty Ranges (SA Murray–Darling NRM region), and 17 sites from the Western Mount Lofty Ranges (Adelaide and Mount Lofty Ranges NRM region).

Eyre Peninsula NRM region

The Eyre Peninsula sites were selected in partnership with the Eyre Peninsula NRM from a list of previously sampled (fixed) sites throughout the region to cover the spatial extent of the stream network accessibe by roads. This included six sites from Tod River and Rock Valley Creek to provide an indication of the condition and recovery of each site 10 years after the 2005 bushfire that burnt much of the catchment. Another three sites were located on Minniribbie and Glengyle creeks to monitor the potential impacts associated with aquaculture farming activities (mostly yabby growing), and one site was located on the Driver River to help clarify any risks associated with potential future mining development in the catchment.

South Australian Murray–Darling Basin NRM region

The sites from the Eastern Mount Lofty Ranges were selected from a list of previously sampled sites to provide a comprehensive spatial coverage of streams that drain into the River Murray and Lower Lakes. They were selected in partnership with the SA Murray–Darling Basin NRM and various government agencies to build on the knowledge relating to a number of long-term sampling sites, contribute to water allocation planning for streams located within high extraction demand zones, and report on the progress of streams subject to rehabilitation by local action planning groups. Sites were distributed in the Marne River, Ferries MacDonald, Angas–Bremer River and Finniss Creek catchments in the mid to southern part of the region but did not include any sites from the Burra Creek catchment in the north.

Adelaide and Mount Lofty Ranges NRM region

Fixed sites from the Western Mount Lofty Ranges were also selected from a list of previously sampled locations from the region in consultation with the Adelaide and Mount Lofty Ranges NRM, Department of Environment, Water and Natural Resources and District Council of Yankalilla. They included two of the best (First Creek Cleland Gully and First Creek in the Fleurieu Peninsula), and two of the worst sites (South Para River and Cox Creek) based on past results from the region, nine sites to assist with water allocation planning and assessment work, three sites affected by the Sampson Flat fire (within the high fire intensity zone) and one site of particular interest to the local government (Congeratinga Creek).

Fixed sites versus random site selection

It is important to note that selecting fixed sites provides targeted information about the sampled sites and gives only a broad indication of the general condition of waters in a region. The lack of randomly selected sites limits the ability for this sort of study design to provide a statistically valid assessment of all waters in a region with some measure of known error (Stevens and Olsen 2004).

The EPA has developed a database covering all stream reaches found in South Australia which can be used to identify randomly selected sites (Catchment Simulations Solution 2011), which would allow the findings to be statistically scaled up to report on the number or proportion of stream reaches in different condition classes or subject to a water quality or habitat disturbance. If this type of information is required in the future then sites can be selected using this approach but as part of negotiations with partner organisations, the above fixed site sampling approach was advocated and used in sampling streams from each region in 2015.

The assessment

Members of the expert panel individually rated each site using a descriptive model for interpreting change in aquatic ecosystems in relation to increasing levels of disturbance (Davies and Jackson 2006). The assumption in this assessment is that biological (ecological) condition deteriorates as the degree of human disturbance in the catchment

increases, and conversely, the best condition occurs where there is little to no human disturbance of the environment (Figure 1).

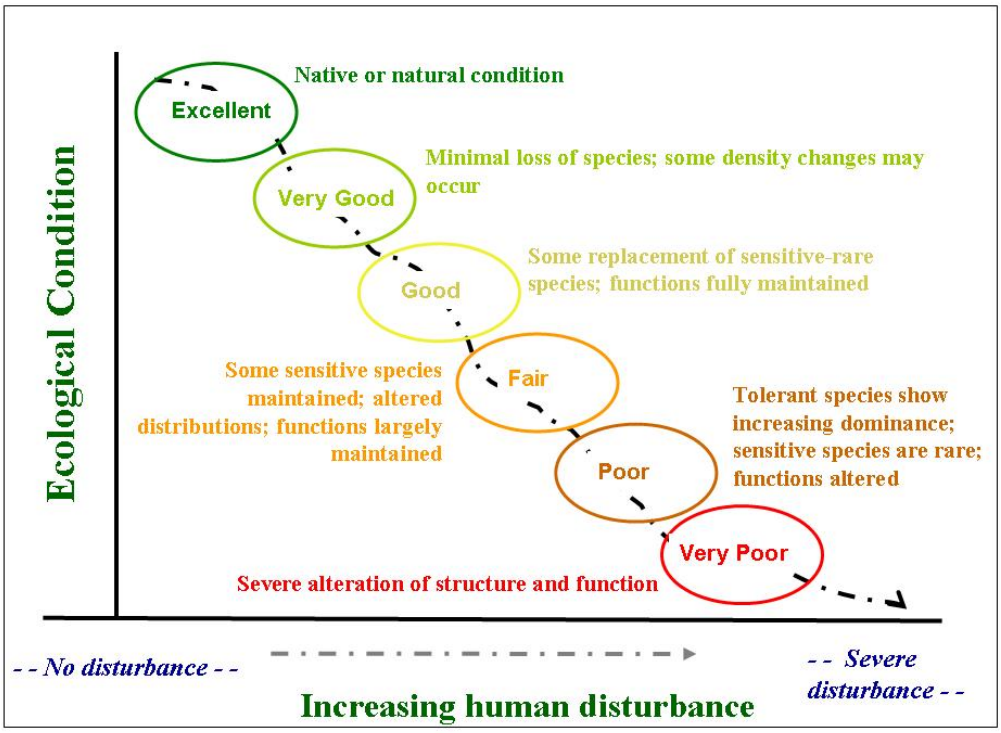

Figure 1 **Human disturbance gradient showing the six different ecological condition grades or ratings ranging from excellent (best) to very poor (worst) with a brief definition of each condition**

The process used to grade or rate sites involved the following steps. Firstly, conceptual models describing the ecological responses to general disturbance gradients were developed, reviewed and updated by the panel; separate models were developed for the Eyre Peninsula, Eastern and Western Mount Lofty Ranges to represent the different stream types that occur in each region (Tables 1–3).

Secondly, species lists were compiled for each model which described the expected biotic assemblage for up to six potential condition ratings, based on the data that was collected in 2015. Separate species lists were developed for the Eyre Peninsula, Eastern and Western Mount Lofty Ranges to describe any obvious biotic differences that occur across these regions (Tables 4–6).

Thirdly, each site was given a rating based on the macro-invertebrate communities, vegetation assemblages, water chemistry and sediment features that were recorded during the autumn and spring sampling periods. For the sites that were consistently dry, only the vegetation data, sediment and habitat features were used to provide a provisional condition rating; during wetter periods. At least some of these sites would probably rate differently but the assessment was based on the conditions that occurred during 2015.

Lastly, the individual ratings derived by the panel members were combined to produce an overall, or final, rating for each site (Table 7).

The final reported ratings were derived by determining the mode (most common rating from the panel ratings for each site); in cases where the panel members disagreed and recommended three possible ratings, the final rating was to be determined by omitting the best and worst rating and selecting the middle rating. In the interests of being open and transparent about the final ratings derived in this process, all results have been included in Table 7 to show where the panel agreed or showed some difference in opinion in terms of rating individual sites.

The ratings in the model range from Excellent to Very Poor. However, given the extent of land clearance, modifications, and dominance of stock grazing and cropping in most catchments, the panel considered that Excellent probably no

longer occurs in the sampled regions and was certainly not evident from the sites sampled in 2015. Similarly, due to the amount of land clearance, lack of remnant native vegetation and dryland salinity issues affecting the majority of catchments on Eyre Peninsula where no streams from that region were expected to represent a Very Good condition.

2015 results

The condition ratings assigned to streams sampled from each region are summarised in Table 8. The results highlight that catchment disturbance has been particularly extensive throughout the Eyre Peninsula (sites only assigned in Fair, Poor and Very Poor condition) whereas the SA Murray Darling Basin and Adelaide and Mount Lofty Ranges include a wider range of high quality through to severely degraded streams. Nevertheless, only 21% and 30% of stream sites from the latter regions rated well, with the remaining 79% and 70% of streams assigned more degraded ratings. This highlights the extent of disturbance that has affected streams across three NRM regions in South Australia.

Table 1 Overall condition ratings (# sites and %) for the sites sampled from each region in 2015.

Condition rating	Eyre Peninsula	SA Murray–Darling Basin	Adelaide and Mount Lofty Ranges	Total number of sites
Excellent	0	0	0	0
Very Good	0	0	2 (12%)	2 (5%)
Good	0	3 (21%)	3 (18%)	6 (15%)
Fair	4 (40%)	5 (36%)	8 (47%)	17 (41%)
Poor	4 (40%)	6 (43%)	4 (24%)	14 (34%)
Very Poor	2 (20%)	0	0	2 (5%)
TOTAL	10	14	17	41

The 2015 sites that were assigned a Very Good rating included First Creek, upstream from the waterfall in the Cleland Conservation Park (CP) near Adelaide, and First Creek, in the Tunkalilla area, on the southern Fleurieu Peninsula. These streams were both characterised by the presence of a large amount of remnant native vegetation within their catchments, flowing freshwater habitats in both autumn and spring, and by the large number of rare, sensitive and/or flow-dependent macro0invertebrates recorded and seen at each site in 2015.

Sites assigned a Good rating included the Finniss River near Yundi, Blackfellows Creek near Kyeema Conservation Park and Ti Tree Creek near McHarg Creek in the SA Murray–Darling Basin, and First Creek below the waterfall in Cleland Gully CP, Callawonga Creek on the Fleurieu Peninsula and Sixth Creek near Castambul in the Adelaide and Mount Lofty Ranges region. These streams are located in the wetter and more vegetated parts of the Mount Lofty Ranges, typically maintain flowing riffle habitats in autumn and spring, functioning riparian zones, characterised by good water quality, and supporting a range of rare, sensitive and flow-dependent aquatic macro-invertebrates.

The Fair sites were located among largely cleared catchments that retained some riparian vegetation, had generally moderate water quality and showed signs of nutrient enrichment affecting the aquatic life inhabiting each stream. They included sites from the Tod River on Eyre Peninsula, several sites spread throughout the SA Murray–Darling Basin (sites in the Bremer River catchment, Meadows Creek, and Deep Creek in the Currency Creek catchment), and the Torrens, South and North Para rivers, Cox, Brownhill, Aldgate, Congeratinga and Cudlee creeks in the Adelaide Hills.

The Poor streams were found among heavily cleared agricultural land used for stock grazing and cropping. They were characterised by a general lack of native vegetation within their catchments, ineffective riparian zones dominated by a few gums over introduced grasses and weeds, poor water quality with evidence of significant nutrient enrichment (eg high nutrient concentrations, large algal and plant growths, anaerobic sediments, and dominance of organic-feeding macro-

invertebrates inhabiting benthic communities). They included the lower Tod River at North Shields and Glengyle and Minniribbie creeks near Wangary on Eyre Peninsula; the latter sites appeared largely unaffected by nearby aquaculture facilities when assessed but were comparable to other salinized streams located within nearby largely cleared catchments.

In the SA Murray–Darling Basin sites included the Marne River near Cambrai, Paris and Gould creeks in the Angas River catchment, Western Flat and Nairne creeks in the Bremer River catchment, and Dry Creek in the Murray Mallee near Monarto. The Western Mount Lofty sites in poor condition included Gould Creek near Little Para Reservoir, Torrens River in the upper catchment near Mount Pleasant, Pedler Creek in urban Palm Valley to the south of Adelaide, and Back Valley Creek near Victor Harbor on the Fleurieu Peninsula.

Very Poor streams were only assigned to two Eyre Peninsula sites that were also located within cleared grazing and cropping lands, and both showed signs of damage caused by dryland salinization (eg low diversity and abundance of saline tolerant aquatic species). They included Rock Valley Creek near Koppio and the Driver River near Verran, north from Port Lincoln.

Variability in panel member ratings

The results in Table 7 show that the members of the expert panel assigned the same condition rating to 60%, 43% and 88% of sites from the Eyre Peninsula, Eastern and Western Mount Lofty Ranges, respectively. The remaining sites from each region only differed by one condition rating of each other. This indicates that there was considerable consistency for rating the sites using this approach and that the conceptual models provided an accurate and interpretable representation of the range of stream types that occurred in each region in 2015.

It is important to note that it would be unrealistic to expect to obtain complete agreement in rating sites using an expert panel approach, or any other means of integrating and reporting on measures of stream condition (eg classifying sites using indices or models based on the reference based concept, gradient analysis, or comparisons against guidelines) due to the problems associated with separating groups along a continuum of possible groups using environmental data that is inherently highly variable.

Water chemistry of South Australian streams

Table 9 provides a statistical summary of the major chemistry and algal biomass (parameters estimated using chlorophyll measurements) taken at each of the wet sites in autumn and spring. The results for each region have been summarised for each season and combined to provide an indication of the measured variation in individual parameters during 2015.

In general, streams from Eyre Peninsula and parts of the Eastern Mount Lofty Ranges had more chlorophyll, higher nitrogen concentrations and were more saline than streams from the Western Mount Lofty Ranges. Seasonal patterns were variable with the highest chlorophyll concentrations being recorded from Eyre Peninsula streams in spring whereas autumn concentrations were higher in the Eastern Mount Lofty Ranges. Total phosphorus and total nitrogen showed a general increase in concentrations in Eastern Mount Lofty Ranges streams in spring compared to autumn but remained at similar levels (Eyre Peninsula) or showed a reduction in total nitrogen concentration during the same period in Western Mount Lofty Ranges streams.

None of the regions sampled have a large number of undisturbed streams covered in remnant native vegetation that can act as reference sites and provide a benchmark for most other streams, which are generally located within highly modified, agriculturally dominated catchments, to be compared against. The few streams that are located within nature conservation reserves (eg First Creek in Cleland Conservation Park) or within rocky, steeply sloping landscapes that have historically been difficult to clear and develop (eg Sixth and Callawonga creeks) and still dominated by native vegetation are not suitable reference streams for all stream types that occur in these regions, since they bear little resemblance to small first and second order tributary streams or the many lowland streams that have typically been surrounded by residential housing.

To overcome this problem, the US EPA (2000) advocate using the 25th percentile of all data from a region to set nutrient thresholds, which are expected to approximate the tipping point where streams are likely to be at increased risk of being

degraded by excessive amounts of nutrients. Using this approach, the nutrient thresholds for each region were as follows.

Region	Total nitrogen	Total phosphorus
Eyre Peninsula	0.9 mg/L	0.04 mg/L
Eastern Mount Lofty Ranges	0.6 mg/L	0.04 mg/L
Western Mount Lofty Ranges	0.37 mg/L	0.02 mg/L

These concentrations are comparable to the values often cited in the scientific literature using the same statistical criterion (see Chambers *et al* 2012 and Smucker *et al* 2013), and similar to the trigger values of *total nitrogen* 0.5 mg/L and *total phosphorus* 0.02 mg/L that were recently proposed for the protection of sensitive mayflies and stoneflies from South Australian waters (Corbin and Goonan 2010).

Conceptual models

A central assumption of the conceptual models was that the high levels of nutrients (eg nitrogen and phosphorus) recorded from South Australian streams originated from human activities in each catchment, rather than from some unknown natural source (eg NLWRA 2001); this is consistent with the general poor nutrient status of ancient Australian soils and the need for native plants to conserve and recycle nutrients, rather than allow the regular export of nitrogen and phosphorus from the land into streams, where the nutrients may eventually be deposited many kilometres away. Consequently, it was assumed that historical and present stock and feral animal grazing land-uses and cropping activities since European settlement have contributed towards the nutrient enrichment of many streams in each region in modern times. This may be evident through measuring higher than expected concentrations of nutrients in water samples (eg TN> 0.5 mg/L or TP> 0.02 mg/L as described above) and/or noting signs of enrichment due to the presence of particularly large growths of phytoplankton, filamentous algae or aquatic plants.

Under such conditions, a generalist assemblage of aquatic macroinvertebrates typically dominates because they are capable of exploiting the high plant productivity and tolerating occasional poor water quality events that often occur in such streams. In contrast, few if any, of the regionally rare, sensitive and/or habitat specialists would be expected to occur in such streams, and never in large numbers. These types of enrichment responses were subsequently incorporated into the conceptual models to represent the biological and chemical patterns that have been described in the scientific literature for well over 100 years.

Similarly, another assumption of the models was that the very high salinity of some streams in each region has been caused, or at least exacerbated, by the extent of native vegetation clearance and replacement by cropping and grazing practices in some catchments in the past, which has in some cases created conditions that has promoted the secondary salinization of streams due to inflow of saline groundwater. High salinity has been recognised as a major factor for the loss of salt sensitive species and creation of conditions that favour only the more salt tolerant species to be able to colonise and subsequently complete their life-cycles.

Recent research indicates that most freshwater species are generally replaced by salt tolerant species when salinities exceed about 5,000-10,000 mg/L, and that different threshold effects are evident with different taxonomic groups (eg Nielsen *et al.* 2008; Kefford *et al.* 2011). While it is possible that some streams from the inland Eyre Peninsula and the Murray Mallee in the Eastern Mount Lofty Ranges may have approached or exceeded this salinity range prior to European settlement, it was assumed as part of this assessment that the extensive land-use changes brought about by farming has mobilised more salt into each affected stream than would have occurred if the landscape had remained unchanged, and that streams with a salinity at or above 5,000 mg/L represent a highly disturbed state in the conceptual models for each region.

Dry sites

It should be noted that the ratings for dry sites in particular, may differ when water is present. This should, however, be considered within the broader context of the variability that will occur in any stream in response to differences in the frequency and timing of floods and droughts, differences in the distribution and abundance of stock and feral animals accessing stream reaches, and the many other biological, chemical and physical habitat changes that undoubtedly occur over time. Despite this, the ratings assigned in this report provide what are expected to be an accurate condition assessment of each site, using the conceptual models that were specifically developed for the three NRM regions that were sampled in 2015.

Comparison with previous years sampling in each region

The Eyre Peninsula and SA Murray–Darling regions were last assessed in 2010, whereas the Adelaide and Mount Lofty region was last assessed in 2013; regions are typically sampled every 5-years to show if any significant changes in condition have occurred in response to any improvements in land-use and management while considering the influence of climate variability in any assessments. The Adelaide and Mount Lofty Ranges is sampled every 2-years because this is the region where most people in the state live and where the greatest range of land-use pressures are likely to occur.

In 2010, of the 30 sites sampled from Eyre Peninsula, 37% were Fair, 50% Poor and 13% Very Poor[1]. The same year, 43 sites were sampled from the SA Murray–Darling region and 2% Very Good, 12% Good, 53% Fair and 33% Poor[2]. In 2013 of the 43 sites sampled from the Adelaide and Mount Lofty region, 4% of sites were Very Good, 22% Good, 30% Fair, 39% Poor and 4% of sites were given a Very Poor rating[3]. Consequently, the results reported here for 2015 are similar to those obtained when each region was last sampled, indicating these patterns have been maintained over at least two subsequent intensive sampling periods.

According to the Bureau of Meteorology climate data[4], 2010 was a wetter than average year across most of the state but temperatures were variable; Eyre Peninsula was slightly cooler than average and parts of the Murray Mallee and Lower Murray region were slightly warmer than average. In 2013, records from Mount Barker indicate that the Adelaide and Mount Lofty Ranges had an average annual rainfall year, with wetter than normal conditions prevailing during the first half of the year followed by a drier than normal second half of the year. It was also a warmer than normal year, with a +1.1ºC above average annual temperature recorded at this station. In 2015, conditions across the South East and coastal areas of the state were generally wetter and warmer than average (+0.86 ºC) but there was nothing obvious from the climate summaries for 2010 and 2013 to indicate that weather variability was significant among the regions sampled during these years.

The lack of change in broad stream condition within each region is not unexpected given the scale of land-use modification that has occurred to most stream catchments post-European settlement. Land-use changes or interventions at sub-catchment scales or similar would probably be needed to cause a significant change in overall stream condition, unless climate forces additional changes beyond our existing knowledge of stream variability across the South Australian landscape.

References

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3 www.epa.sa.gov.au/files/8498_aecr_panel_2013.pdf

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Further information

Legislation

Online legislation is freely available. Copies of legislation are available for purchase from:

Service SA Government Legislation Outlet
Adelaide Service SA Centre
108 North Terrace
Adelaide SA 5000

Telephone: 13 23 24
Facsimile: (08) 8204 1909
Website: <shop.service.sa.gov.au>
Email: <ServiceSAcustomerservice@sa.gov.au>

General information

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Table 1 Conceptual model of ecological responses to a disturbance gradient in the Eyre Peninsula NRM region

Rating	Excellent	Very Good	Good	Fair	Poor	Very Poor
Stressor description	As naturally occurs; no longer present on Eyre Peninsula due to the extensive level of vegetation clearance and landscape modification in the region.	Least impacted; no longer likely to be present on Eyre Peninsula due to the extensive level of vegetation clearance and landscape modification in the region.	Best condition sites showing initial signs of enrichment; only likely to occur in parts of the upper Tod River catchment and other well vegetated stream reaches on some occasions.	Moderate enrichment; likely to commonly occur in the region due to the extent of vegetation clearance and associated agricultural development.	Gross enrichment; likely to commonly occur in the region due to the extent of vegetation clearance and associated agricultural development. Ephemeral and saline streams in the region are likely to show extensive enrichment effects due to the lack of dilution flows.	Severely altered; likely to occur in the region in highly degraded salinised, ephemeral streams in extensively cleared catchments. Sites assigned to this rating will be affected by a toxicant or other disturbance that significantly limits the diversity and abundance of aquatic life.
Biological assemblages	Native assemblages; usually with many rare or sensitive species present; typically high Ephemeroptera, Plecoptera and Trichoptera (EPT) richness; no symptoms of stress and no introduced aquatic species present. Note that ephemeral habitats may have a rich fauna of colonising insects (eg beetles, waterbugs and dipterans) but usually abundances of all species are low.	Best of what is left assemblages; high richness; intolerants and specialist taxa dominate abundances; may include some introduced species present in low abundances.	Typical assemblages for least impacted streams; good richness; generalist assemblage that includes at least some rare and sensitive species; emerging symptoms of stress in relation to nutrients and fine sediments; at least some remnant native vegetation present.	Impaired assemblages; generalist and tolerant taxa dominate numbers which usually includes some very abundant taxa; sensitive and rare taxa, if present, present in very low numbers; usual absence of some taxa expected for the available habitats present; at least some trees present in the local catchment and banks.	Degraded assemblages; tolerant and generalist taxa dominate but numbers usually reduced, although 1–2 generalist taxa may be present in high abundances; only 1–2 rare or sensitive species present in low abundances or absent; often few or 1–2 scattered trees in the catchment and banks.	Severely degraded assemblages with few taxa and generally low abundances; may have large numbers of one tolerant taxon such as an oligochaete, mosquito larvae, amphipod (*Austrochiltonia*) or midge (eg *Chironomus, Procladius* and *Tanytarsus)*; can include organic feeders from highly polluted waters such as syrphid larvae; vegetation often completely comprised introduced species with little to no remnant native vegetation.

Rating	Excellent	Very Good	Good	Fair	Poor	Very Poor
Water chemistry conditions	As naturally occurs; no human contaminants present and pest species not impacting on water quality (eg nutrients, hormones).	Best condition sites with associated water quality; high proportion natural features means well oxygenated and low in nutrients and turbidity. May include freshwater and naturally saline streams.	Largely unremarkable water quality with at least some nutrients present at higher than expected concentrations; coupled with at least one plant indicator showing emerging signs of enrichment effects (eg either chlorophyll *a* >10 ug/L, macrophyte cover >35% cover and/or filamentous algae >10% cover) but site not overwhelmed.	Fair water quality with generally saturated dissolved oxygen (when sampled during the day); at least one nutrient present at high concentrations and high algal and higher plant growths (eg either chlorophyll a >10 ug/L, macrophyte cover >35% cover and/or filamentous algae >10% cover) evident on occasions.	Poor water quality with generally saturated dissolved oxygen (when sampled during the day); nutrients present at high concentrations and high plant productivity evident at the site (eg usually chlorophyll a >10 ug/L, macrophyte cover >35% cover and filamentous algae >10% cover) most of the time.	Very poor water quality with at least one parameter at a toxicant concentration that limits aquatic diversity; often very low dissolved oxygen and may be saline and enriched in nutrients but algal and plant growth limited.
Physical habitat and flow patterns	Natural habitat and flow patterns; no farm dams present; range sediment types and not always anaerobic.	Near natural habitat and flow regimes; mostly well vegetated catchments with few dams present; range sediment types and not always anaerobic.	Good habitat structure and flow patterns; extent of dam development has not caused an obvious loss of riffle habitats; range sediment types and not always anaerobic.	Fair habitat structure and flow patterns; many dams may be present in the catchment; anaerobic fine sediments usually present except when large algal growths present.	Poor habitat structure and flow patterns; may have many dams present in the catchment; anaerobic fine sediments usually present except when large algal growths present.	Severe modifications to physical habitat and flow patterns; little to no remnant native vegetation remaining; cleared agricultural or urban sites; anaerobic fine sediments often dominate.

Rating	Excellent	Very Good	Good	Fair	Poor	Very Poor
Human activities and sources in the catchment	No obvious human disturbances but may include roads and sparse residential housing that is sewered; no point sources and diffuse pollution not detectable by the extent of vegetation surrounding the waterway.	No significant human disturbances but may include some sewered housing and roads; no point source discharges and diffuse pollution not obviously affecting the aquatic ecosystem due to the extent of vegetation surrounding the waterway.	Effects of human disturbance becoming obvious; point sources may be present but do not dominate flows; good riparian zones help to mitigate diffuse pollution effects.	Point and diffuse source enrichment effects evident; riparian zone not effective at mitigating nutrients and fine sediment entering waterway.	Obvious point and diffuse source enrichment effects present; unbuffered channel; major changes to catchment land use with little remnant vegetation remaining and agriculture and/or urban uses dominate.	Severe point and/or diffuse source effects that may include toxicant responses; effects dominate water quality and biological response with little signs of the original waterway evident; unbuffered channel that has undergone extreme modifications in an agricultural or urban setting.

Table 2 Conceptual model of ecological responses to a disturbance gradient in the SA Murray–Darling Basin NRM region

Rating	Excellent	Very good	Good	Fair	Poor	Very poor
Stressor description	As naturally occurs; no longer present in the Eastern Mount Lofty Ranges due to the level of vegetation clearance and landscape modification.	Least impacted; not common in the region due to the extent of vegetation clearance and landscape modification. Parts of the Finniss River catchment are likely to represent this condition on occasion, particularly from permanently/near permanently flowing freshwater habitats.	Best condition sites showing initial signs of enrichment; only likely to occur in parts of the Finniss River catchment on occasion due to the presence of permanently/near permanently flowing freshwater habitats. Elsewhere the level of clearance and associated agricultural development is likely to cause significant nutrient enrichment and sediment effects	Moderate enrichment; likely to commonly occur in the region due to the extent of vegetation clearance and associated agricultural development.	Gross enrichment; likely to commonly occur in the region due to the extent of vegetation clearance and associated agricultural development. Ephemeral streams in the region are likely to show extensive enrichment effects due to the lack of dilution flows.	Severely altered; may occur in the region in urban stream reaches, downstream from wastewater discharges and highly degraded ephemeral streams in agricultural settings. Sites assigned to this rating will be affected by a toxicant or other disturbance that significantly limits the diversity and abundance of aquatic life.
Biological assemblages	Native assemblages; usually with many rare or sensitive species present; typically high Ephemeroptera, Plecoptera and Trichoptera (EPT) richness; no symptoms of stress and no introduced aquatic species present. Note that ephemeral habitats may have a rich fauna of colonising insects	Best of what is left assemblages; high richness; intolerants and specialist taxa dominate abundances; may include some introduced species present in low abundances.	Typical assemblages for least impacted streams; good richness; generalist assemblage that includes at least some rare and sensitive species; emerging symptoms of stress in relation to nutrients and fine sediments; at least some remnant native vegetation present.	Impaired assemblages; generalists and tolerant taxa dominate numbers which usually includes some very abundant taxa; sensitive and rare taxa, if present, present in very low numbers; usual absence of some taxa expected for the available habitats present; at least some trees present in the	Degraded assemblages; tolerants and generalists dominate but numbers usually reduced although 1–2 generalist taxa may be present in high abundances; only 1–2 rare or sensitive species present in low abundances or absent; often few or 1–2 scattered trees in the catchment and banks.	Severely degraded assemblages with few taxa and generally low abundances; may have large numbers of one tolerant taxon such as oligochaetes, mosquito larvae, amphipods (*Austrochiltonia*) or midges (eg *Chironomus, Procladius* and *Tanytarsus)*; can include organic feeders from highly polluted waters such as syrphid larvae;

Rating	Excellent	Very good	Good	Fair	Poor	Very poor
	(eg beetles, waterbugs and dipterans) but usually abundances of all species are low.			local catchment and banks.		vegetation often completely comprised introduced species with little to no remnant native vegetation.
Water chemistry conditions	As naturally occurs; no human contaminants present and pest species not impacting on water quality (eg nutrients, hormones).	Best condition sites with associated water quality; high proportion natural features means well oxygenated and low in nutrients and turbidity.	Largely unremarkable water quality with at least some nutrients present at higher than expected concentrations; coupled with at least one plant indicator showing emerging signs of enrichment effects (eg either chlorophyll *a* >10 ug/L, macrophyte cover >35% cover and/or filamentous algae >10% cover) but site not overwhelmed.	Fair water quality with generally saturated dissolved oxygen (when sampled during the day); at least one nutrient present at high concentrations and high algal and higher plant growths (eg either chlorophyll a >10 ug/L, macrophyte cover >35% cover and/or filamentous algae >10% cover) evident on occasions.	Poor water quality with generally saturated dissolved oxygen (when sampled during the day); nutrients present at high concentrations and high plant productivity evident at the site (eg usually chlorophyll a >10 ug/L, macrophyte cover >35% cover and filamentous algae >10% cover) most of the time.	Very poor water quality with at least one parameter at a toxicant concentration that limits aquatic diversity; often very low dissolved oxygen and may be saline and enriched in nutrients but algal and plant growth limited.
Physical habitat and flow patterns	Natural habitat and flow patterns; no farm dams present; range sediment types and not always anaerobic.	Near natural habitat and flow regimes; mostly well vegetated catchments with few dams present; range sediment types and not always anaerobic.	Good habitat structure and flow patterns; extent of dam development has not caused an obvious loss of riffle habitats; range sediment types and not always anaerobic.	Fair habitat structure and flow patterns; many dams may be present in the catchment; anaerobic fine sediments usually present except when large algal growths present.	Poor habitat structure and flow patterns; may have many dams present in the catchment; anaerobic fine sediments usually present except when large algal growths present.	Severe modifications to physical habitat and flow patterns; little to no remnant native vegetation remaining; cleared agricultural or urban sites; anaerobic fine sediments often dominate.

Rating	Excellent	Very good	Good	Fair	Poor	Very poor
Human activities and sources in the catchment	No obvious human disturbances but may include roads and sparse residential housing that is sewered; no point sources and diffuse pollution not detectable by the extent of vegetation surrounding the waterway.	No significant human disturbances but may include some sewered housing and roads; no point source discharges and diffuse pollution not obviously affecting the aquatic ecosystem due to the extent of vegetation surrounding the waterway.	Effects of human disturbance becoming obvious; point sources may be present but do not dominate flows; good riparian zones help to mitigate diffuse pollution effects.	Point and diffuse source enrichment effects evident; riparian zone not effective at mitigating nutrients and fine sediment entering waterway.	Obvious point and diffuse source enrichment effects present; unbuffered channel; major changes to catchment land use with little remnant vegetation remaining and agriculture and/or urban uses dominate.	Severe point and/or diffuse source effects that may include toxicant responses; effects dominate water quality and biological response with little signs of the original waterway evident; unbuffered channel that has undergone extreme modifications in an agricultural or urban setting.

Table 3 Conceptual model of ecological responses to a disturbance gradient in the Adelaide and Mount Lofty Ranges NRM region

Rating	Excellent	Very Good	Good	Fair	Poor	Very Poor
Stressor description	As naturally occurs; probably no longer present in the western Mount Lofty Ranges due to the level of vegetation clearance and landscape modification. Streams with natural vegetation communities, such as First and Sixth creeks and low order streams in the upper South Para River in the Mount Lofty Ranges, and coastal creeks on the southern Fleurieu Peninsula (eg Aaron Creek, lower reaches of Deep and First creeks) may represent this state on occasions but the presence of introduced species and nutrient enrichment associated with human uses in the catchment precludes rating sites in the region as Excellent.	Least impacted streams with largely natural vegetation and low levels of human disturbance are not common in the region and may only include First and Sixth creeks and low order streams in the upper South Para River in the Mount Lofty Ranges, and coastal creeks on the southern Fleurieu Peninsula (eg Aaron Creek, lower reaches of Deep and First creeks). These streams have few introduced species present and show little sign of nutrient enrichment.	Best condition sites showing initial signs of enrichment; likely to occur in streams with large areas of natural vegetation remaining in their catchments and generally characterised by permanent/near permanent, flowing, freshwater habitats but may also include more ephemeral habitats. Numerous streams in the watersheds of all the water reservoirs in the region would be expected to represent this condition in most years.	Moderate nutrient enrichment; likely to commonly occur in the region due to the extent of vegetation clearance and associated agricultural development. This is likely to result in significant nutrient enrichment and sediment effects, and result in poorer ratings being assigned.	Gross nutrient enrichment or degradation; likely to commonly occur in the region due to the extent of vegetation clearance and associated agricultural development and urbanisation. Ephemeral and saline streams in the region are likely to show extensive enrichment effects due to the lack of substantial dilution flows in most years.	Severely altered; may occur in the region in urban stream reaches, downstream from wastewater discharges and highly degraded ephemeral and more permanent streams in extensively cleared agricultural settings. Sites assigned to this rating will be affected by a toxicant or other disturbance that significantly limits the diversity and abundance of aquatic life present in a stream.

Rating	Excellent	Very Good	Good	Fair	Poor	Very Poor
Biological assemblages	Native assemblages of plants and animals; usually with many rare or sensitive species present; typically high Ephemeroptera, Plecoptera and Trichoptera (EPT) richness; no symptoms of stress or introduced aquatic species present. Temporary and ephemeral habitats have a low EPT richness but provide habitat for many colonising insects (eg beetles, waterbugs and dipterans); abundances of all species generally low.	Best of what is left, least disturbed assemblages; high richness; intolerants and specialist taxa dominate abundances; may include some introduced species present in low abundances.	Typical assemblages for least impacted streams; good richness; generalist assemblage that includes at least some rare and sensitive species; emerging symptoms of stress in relation to nutrients and fine sediments; at least some remnant native vegetation present.	Impaired assemblages; generalists and tolerant taxa dominate numbers which usually includes some very abundant taxa; sensitive and rare taxa, if present, present in very low numbers; usual absence of some taxa expected for the available habitats present; at least some trees present in the local catchment and on the banks.	Degraded assemblages; tolerant and generalist species dominate but numbers usually reduced, although 1–2 generalist taxa may be present in high abundances; only 1–2 rare or sensitive species present in low abundances or absent; often only few scattered trees in the catchment and on the banks.	Severely degraded assemblages with few taxa and generally low abundances; may have large numbers of one tolerant taxon, such as worms, mosquito larvae, amphipods (*Austrochiltonia*) or midges (*Chironomus, Tanytarsus or Procladius)*; can include organic feeders in highly polluted waters (eg syrphid larvae); vegetation often completely comprised introduced or planted species.
Water chemistry conditions	As naturally occurs; no human sources of contaminants present and pest species not impacting on water quality (eg nutrient enrichment, deposits of waste with high levels of hormones).	Least disturbed; high proportion natural features means waters are well oxygenated and low in nutrients and turbidity; may be coloured due to tannins sourced from native plants.	Largely unremarkable water quality with at least some nutrients present at higher concentrations than expected, coupled with at least one plant indicator showing emerging signs of enrichment effects (eg chlorophyll *a* >10 ug/L, filamentous algae >10%	Fair water quality with generally saturated dissolved oxygen (when sampled during the day), at least one nutrient present at a high concentration and high plant productivity (eg chlorophyll *a* >10 ug/L, filamentous algae >10% cover and/or macrophytes	Poor water quality with generally saturated dissolved oxygen (when sampled during the day), nutrients present at high concentrations and high plant productivity evident at the site (eg usually chlorophyll *a* >10 ug/L, filamentous algae >10% cover and macrophytes	Very poor water quality with at least one parameter at a toxicant concentration that is likely to limit the aquatic diversity of a stream; often very low dissolved oxygen and may be saline and enriched in nutrients but algal and plant growth limited.

Rating	Excellent	Very Good	Good	Fair	Poor	Very Poor
			cover and/or macrophytes >35% cover) but site not overwhelmed.	>35% cover) evident on occasions.	>35% cover) most of the time.	
Physical habitat and flow patterns	Natural habitat and flow patterns; no or few farm dams present; range of sediment types present and not always anaerobic.	Near natural habitat and flow regimes; mostly well vegetated catchments with few dams present; range of sediment types present and not always anaerobic.	Good habitat structure and flow patterns; extent of dam development has not caused an obvious loss of riffle (flowing) habitats; range of sediment types present and not always anaerobic.	Fair habitat structure and flow patterns; many dams may be present in the catchment and likely to affect flow patterns; anaerobic fine sediments usually present, except when large algal growths occur and oxygenate the sediments.	Poor habitat structure and flow patterns; may have many dams present in the catchment and obviously affect flow patterns; anaerobic fine sediments usually present, except when large algal growths occur and oxygenate the sediments.	Severe modifications to physical habitat and usually with unnatural flow patterns due to abstraction or discharges; little to no remnant native vegetation remaining; cleared agricultural or urban sites; anaerobic fine sediments, rip-rap or alien sediments often present.
Human activities and sources in the catchment	No obvious human disturbances but may include roads and sparse rural housing; no point sources and diffuse pollution not detectable, largely due to the extent of vegetation surrounding each stream.	No significant human disturbances but may include some rural housing and roads; no point source discharges and diffuse pollution not obviously affecting the aquatic ecosystem due to the extent of native vegetation surrounding each stream.	Effects of human disturbance becoming obvious; point sources may be present but do not dominate flows; good buffer zones and/or riparian vegetation present that help to mitigate diffuse pollution effects from surrounding land uses.	Point and diffuse source enrichment effects evident; riparian zone not effective at mitigating nutrients and fine sediment typically entering these streams.	Obvious point and/or diffuse source enrichment effects present; unbuffered channel with ineffective riparian vegetation other than introduced grasses; major changes to catchment land use with little remnant vegetation remaining and agriculture and/or urban uses dominate.	Severe point and/or diffuse source effects that may include toxicant responses; effects dominate water quality and biological response with little signs of the original waterway evident; unbuffered channel that has undergone extreme modifications in an urban or agricultural setting.

Table 4 List of biota expected to occur for each grade in the Eyre Peninsula NRM Region

Note: pristine and very good conditions no longer occurs.

Streams in an Excellent and Very Good condition probably no longer occur in the region. They would be expected to support several caddisflies, tolerant mayflies and flow dependent dipterans and beetles, and have no introduced species present. A number of species recorded from the region in 2013 were not collected in 2015 including a snail (*Glyptophysa*), several beetles (*Eretes, Rhantus* and *Platynectes*), and caddisflies (*Symphitoneuria* and *Cheumatopysche*).

	Good	Fair	Poor	Very Poor
Attribute 1* Rare and/or regionally endemic (only found in highly saline systems)	None present	None present	None present	None present
Attribute 2 Sensitive, rare or vulnerable specialist taxa with narrow environmental requirements	None present	None present	None present	None present
Attribute 3 Sensitive, ubiquitous taxa	None present	None present	None present	None present
Attribute 4 Opportunistic or generalist taxa	**Mollusca** *Angrobia;* **Hydracarina** *Oxus;* **Trichoptera** *Hellyethira*, *Notalina, Triplectides;* **Odonata** *Xanthagrion, Austroagrion*, *Austrolestes*, *Hemicordulia,* Aeschnidae*;* **Diptera** *Cladotanytarsus;* **Coleoptera** Hydrophilidae *Paracymus, Berosus* and *Limnoxenus*; *Ochthebius*; Dytiscidae *Sternopriscus* and *Necterosoma*	**Mollusca** *Angrobia*, **Hydracarina** *Oxus;* **Trichoptera** *Hellyethira*, *Notalina, Triplectides;* **Odonata** *Xanthagrion, Austroagrion*, *Austrolestes, Hemicordulia,* Aeschnidae*;* **Diptera** Chironomidae *Cladotanytarsus, Tanytarsus;* **Coleoptera** Hydrophilidae *Paracymus*, Berosus and *Limnoxenus; Ochthebius*; Dytiscidae *Necterosoma penicillatus* (only in saline systems)	**Mollusca** *Angrobia;* **Trichoptera** *Notalina, Triplectides;* **Odonata** *Austrolestes*, *Hemicordulia,* Aeschnidae*;* **Diptera** Chironomidae *Cladotanytarsus, Tanytarsus;* **Coleoptera** Hydrophilidae *Paracymus, Berosus* and *Limnoxenus*; *Ochthebius*; Dytiscidae *Eretes, Rhantus, Necterosoma penicillatus* (only in saline systems)	**Diptera** Chironomidae *Tanytarsus*; **Coleoptera** *Necterosoma penicillatus*

	Good	Fair	Poor	Very Poor
Attribute 5 Tolerant taxa	**Oligochaeta; Amphipoda** *Austrochiltonia*; **Diptera** *Simulium*; Culicidae; Stratiomyidae; **Odonata** *Ischnura*	**Turbellaria; Oligochaeta; Mollusca** Hydrobiidae**;** *Coxiella;* **Hydracarina** *Koenikea, Recifella, Arrenurus;* **Amphipoda** *Austrochiltonia*; **Collembola**; **Diptera** *Simulium*; Culicidae; Stratiomyidae; Chironomidae *Procladius, Dicrotendipes, Paralimnophyes*; **Hemiptera** *Micronecta, Sigara, Agraptocorixa, Anisops, Enithares;* **Odonata** *Ischnura*	**Turbellaria; Oligochaeta; Mollusca** *Coxiella;* Hydrobiidae **Hydracarina** *Koenikea, Recifella, Arrenurus;* **Amphipoda** Austrochiltonia; **Collembola**; **Diptera** *Simulium*; Culicidae*;* Ceratopogonidae*;* Chironomidae *Procladius, Chironomus, Dicrotendipes, Paralimnophyes*; Ephydridae; Stratiomyidae; **Hemiptera** *Micronecta, Sigara, Agraptocorixa, Anisops, Enithares;* **Odonata** *Ischnura*	**Oligochaeta** (often in large numbers)**; Hydracarina** *Koenikea, Recifella, Arrenurus;* **Amphipoda** *Austrochiltonia*; **Collembola**; **Diptera** Culicidae*;* Ceratopogonidae; Chironomidae *Procladius, Paracladopelma, Chironomus, Tanytarsus barbitarsus*; Ephydridae; Stratiomyidae; **Hemiptera** *Micronecta, Anisops*
Attribute 6 Non-endemic or introduced taxa	**Mollusca** *Potamopyrgus* in low numbers	**Mollusca** *Potamopyrgus;* **Fish** *Gambusia*	**Mollusca** *Potamopyrgus;* **Fish** *Gambusia*	**Fish** *Gambusia* (rarely present due to poor water quality)

Table 5 List of biota expected to occur for site rating in the SA Murray Darling Basin NRM region

Streams in an Excellent condition probably no longer occur in the region. They would be expected to support some sensitive and rare species, similar to sites in Very Good condition, but have no introduced species present. A number of species recorded from the region in 2013 were not collected in 2015 including several mayflies (*Tasmanophlebia* and *Offadens*), stoneflies (*Leptoperla* and *Illiesoperla*), caddisflies (*Ethochorema, Ulmerophlebia, Taschorema, Orthotrichia, Lingora, Atriplectides* and *Notalina fulva*) and a blackfly (*Paracnephia*), chironomid (*Rheotanytarsus*), beetle (*Laccophilus*) and odonate (*Nososticta*).

Attribute	Very Good	Good	Fair	Poor	Very Poor
Attribute 1* Rare and/or regionally endemic	**Elmidae** *Coxelmis v. fasciatus;* **Fish** *Galaxias olidus*	**Elmidae** *Coxelmis v. fasciatus;* **Fish** *Galaxias olidus*	**Elmidae** *Coxelmis v. fasciatus;* **Fish** *Galaxias olidus*	None present	None present
Attribute 2 Sensitive, rare or vulnerable specialist taxa with narrow environmental requirements	**Plecoptera** *Riekoperla;* **Trichoptera** *Triplectides similis;* **Diptera** *Austrosimulium*	**Plecoptera** *Riekoperla;* **Trichoptera** *Triplectides similis;* **Diptera** *Austrosimulium*	**Diptera** *Austrosimulium*	None present	None present
Attribute 3 Sensitive, ubiquitous taxa	**Ephemeroptera** *Thraulophlebia, Atalophlebia;* **Plecoptera** *Dinotoperla, Austrocerca*	**Ephemeroptera** *Thraulophlebia, Atalophlebia;* **Plecoptera** *Dinotoperla, Austrocerca*	**Ephemeroptera** *Thraulophlebia, Atalophlebia*	**Ephemeroptera** *Atalophlebia*	None present in region
Attribute 4 Opportunistic or generalist taxa	**Mollusca** *Angrobia, Glyptophysa;* **Ephemeroptera** *Cloeon, Tasmanocoenis;* **Trichoptera** *Notalina, Oecetis, Triplectides, Hellyethira, Lectrides;* **Odonata** *Coenagrionidae (Xanthagrion, Austroagrion),*	**Mollusca** *Angrobia, Glyptophysa;* **Ephemeroptera** *Cloeon, Tasmanocoenis;* **Trichoptera** *Notalina, Oecetis, Triplectides, Hellyethira, Lectrides;* **Odonata** *Coenagrionidae (Xanthagrion, Austroagrion), Austrolestes, Hemicordulia,*	***Mollusca*** *Angrobia, Glyptophysa;* **Ephemeroptera** *Cloeon, Tasmanocoenis;* **Trichoptera** *Notalina, Oecetis, Triplectides, Hellyethira, Lectrides;* **Odonata** *Austrolestes, Hemicordulia;* **Diptera** *Dixidae, Ceratopogonidae*	**Mollusca** *Angrobia, Glyptophysa;* **Ephemeroptera** *(in low numbers) Cloeon, Tasmanocoenis;* **Trichoptera** *Triplectides, Hellyethira;* **Odonata** *Austrolestes, Hemicordulia;* **Diptera** *Chironomidae (Tanytarsus);* **Coleoptera**	**Diptera** *Chironomidae (Tanytarsus);* **Coleoptera** *Necterosoma*

Attribute	Very Good	Good	Fair	Poor	Very Poor
	Austrolestes, Hemicordulia, Aeschnidae, Telephlebiidae; **Diptera** *Dixidae, Ceratopogonidae* ***(****Alluauadomyia),* *Chironomidae (Thienemaniella, Corynoneura and Podonomopsis);* **Coleoptera** *Limnoxenus, Macrogyrus, Aulonogyrus*	*Aeschnidae, Telephlebiidae;* **Diptera** *Dixidae, Ceratopogonidae* ***(****Alluauadomyia),* *Chironomidae (Thienemaniella, Corynoneura, Cladotanytarsus, Tanytarsus and Podonomopsis);* **Coleoptera** *Sternopriscus, Limnoxenus, Macrogyrus, Aulonogyrus, Platynectes*	***(****Alluauadomyia)* *Chironomidae (Thienemaniella, Corynoneura, Cladotanytarsus, Tanytarsus and Podonomopsis);* **Coleoptera** *Sternopriscus, Limnoxenus, Macrogyrus, Aulonogyrus, Platynectes*	*Sternopriscus, Necterosoma, Platynectes*	
Attribute 5 Tolerant taxa	**Oligochaeta; Amphipoda** *Austrochiltonia*; **Diptera** *Simulium***; Odonata** *Ischnura*	**Oligochaeta; Amphipoda** *Austrochiltonia*; **Decapoda** *Paratya, Cherax;* **Diptera** *Simulium,* Culicidae, Stratiomyidae, Ceratopogonidae, *Cricotopus;* **Odonata** *Ischnura*	**Turbellaria; Oligochaeta; Mollusca** Hydrobiidae*;* **Amphipoda** *Austrochiltonia*; **Hydracarina** *Eylais;* **Decapoda** *Paratya, Cherax*; **Collembola; Diptera** *Simulium***,** Culicidae, Psychodidae, *Cricotopus;* **Hemiptera** *Micronecta, Sigara, Agraptocorixa, Anisops, Enithares;* **Odonata** *Ischnura*	**Turbellaria; Oligochaeta; Mollusca** Hydrobiids; **Amphipoda** *Austrochiltonia*; **Decapoda** *Paratya, Cherax*; **Hydracarina** *Eylais;* **Collembola**; **Diptera** *Simulium,* Culicidae, Ceratopogonidae, Psychodidae, *Cricotopus*, Ephydridae, Stratiomyidae; **Hemiptera** *Micronecta, Sigara, Agraptocorixa, Anisops, Enithares;* **Odonata** *Ischnura*	**Oligochaeta** (often in large numbers)**; Amphipoda** *Austrochiltonia*; **Collembola**; **Diptera** *Procladius*, *Chironomus* (often in large numbers), Culicidae, Ceratopogonidae, Psychodidae, Stratiomyidae; **Hemiptera** *Micronecta, Anisops*
Attribute 6 Non-endemic or introduced taxa	**Mollusca** *Physa, Potamopyrgus* in low numbers	**Mollusca** *Physa, Potamopyrgus* in low numbers	**Mollusca** *Physa, Potamopyrgus;* **Fish** *Gambusia*	**Mollusca** *Physa, Potamopyrgus;* **Fish** *Gambusia*	**Mollusca** *Physa;* **Fish** *Gambusia* (rarely due to poor water quality)

Table 6 List of biota expected to occur for each site rating in the Adelaide and Mount Lofty Ranges NRM region

Streams in an Excellent condition probably no longer occur in the region. They would be expected to support some sensitive and rare species, similar to sites in very good condition, but have no introduced species present. A number of species recorded from the region in 2013 were not collected in 2015 including a mayfly (*Tasmanophlebia*), several caddisflies (*Ulmerochorema, Leptorussa* and *Orphninotrichia*), and a dipteran family (*Thaumaliidae*). A few species collected in 2011 have not been detected from the region during either 2013 or 2015, including a caddisfly (*Anisocentropus*) and hemipteran (*Hydrometra*).

	Very Good	Good	Fair	Poor	Very Poor
Attribute 1 Rare and/or regionally endemic	**Trichoptera** *Apsilochorema* and Tasimiidae*;* **Fish** *Galaxias olidus*	**Trichoptera** *Apsilochorema* and Tasimiidae*;* **Fish** *Galaxias olidus*	**Fish** *Galaxias olidus*	None present	None present
Attribute 2 Sensitive, rare or vulnerable specialist taxa with narrow environmental requirements	**Ephemeroptera** *Offadens*, *Centroptilum, Nousia fuscula;* **Plecoptera** *Illiesoperla, Newmanoperla, Riekoperla*; **Trichoptera** *Lingora, Triplectides similis, Taschorema, Oxyethira columba, Orthotrichia, Cheumatopysche;* **Odonata** *Hemigomphus, Austrogomphus;* **Diptera** *Paracnephia,* Chironomidae (*Riethia, Aphroteniella* and *Apsectrotanypus);* **Coleoptera** *Simsonia, Sclerocyphon*	**Ephemeroptera** *Offadens, Centroptilum, Nousia fuscula*; **Plecoptera** *Illiesoperla, Newmanoperla, Riekoperla;* **Trichoptera** *Lingora, Triplectides similis, Taschorema, Orthotrichia, Cheumatopysche;* **Odonata** *Hemigomphus, Austrogomphus;* **Diptera** *Paracnephia,* Chironomidae (*Riethia, Aphroteniella* and *Apsectrotanypus);* **Coleoptera** *Simsonia, Sclerocyphon*	**Ephemeroptera** *Offadens*; **Plecoptera** *Illiesoperla, Riekoperla;* **Trichoptera** *Lingora, Triplectides similis, Taschorema, Cheumatopysche*	None present	None present

	Very Good	Good	Fair	Poor	Very Poor
Attribute 3 Sensitive, ubiquitous taxa	**Ephemeroptera** *Thraulophlebia, Atalophlebia spp;* **Plecoptera** *Dinotoperla, Austrocerca;* **Diptera** *Austrosimulium, Simulium melatum*	**Ephemeroptera** *Thraulophlebia, Atalophlebia spp;* **Plecoptera** *Dinotoperla, Austrocerca;* **Diptera** *Austrosimulium, Simulium melatum*	**Ephemeroptera** *Thraulophlebia, Atalophlebia spp;* **Plecoptera** *Dinotoperla, Austrocerca;* **Diptera** *Austrosimulium, Simulium melatum*	**Ephemeroptera** *Atalophlebia australis (low numbers);* **Plecoptera** *Austrocerca* (low numbers if present)	None present
Attribute 4 Opportunistic or generalist taxa	**Hydracarina** *(Oxus, Procorticacarus, Piona, Oribatidae);* **Mollusca** *Angrobia, Ferrissia, Glyptophysa, Corbiculina, Sphaerium;* **Ephemeroptera** *Cloeon, Tasmanocoenis;* **Trichoptera** *Notalina, Oecetis, Triplectides, Hydroptila, Hellyethira, Ecnomus, Lectrides;* ***Odonata*** *Aeschnidae, Telephlebiidae;* **Diptera** *Dixidae, Empididae, Chironomidae: Eukiefferiella, Thienemaniella, Rheotanytarsus (flowing habitats);* **Coleoptera** low numbers of aquatic beetles may be present	**Hydracarina** *(Oxus, Procorticacarus, Piona, Oribatidae);* **Mollusca** *Angrobia, Ferrissia, Glyptophysa; Corbiculina, Sphaerium* **Ephemeroptera** *Cloeon, Tasmanocoenis;* **Trichoptera** *Notalina, Oecetis, Triplectides, Hydroptila, Hellyethira, Ecnomus, Lectrides;* **Odonata** *Xanthagrion, Austrolestes, Hemicordulia, Aeschnidae, Telephlebiidae;* **Diptera** *Dixidae, Empididae, Stratiomyidae, Chironomidae: Eukiefferiella, Thienemaniella, Cladotanytarsus, Rheotanytarsus (flowing habitats);* **Coleoptera** *Sternopriscus, Necterosoma, Chostonestes, Limnoxenus, Macrogyrus, Platynectes*	**Hydracarina** *(Oxus, Procorticacarus, Piona, Oribatidae);* **Mollusca** *Angrobia, Ferrissia, Glyptophysa (often in high numbers)' Corbiculina;* **Ephemeroptera** *Cloeon, Tasmanocoenis;* **Trichoptera** *Notalina, Oecetis, Triplectides, Hydroptila, Hellyethira, Ecnomus, Lectrides;* **Odonata** *Xanthagrion, Austrolestes, Hemicordulia;* **Diptera** *Dixidae, Stratiomyidae, Chironomidae: Eukiefferiella, Thienemaniella, Cladotanytarsus, Rheotanytarsus (flowing habitats);* **Coleoptera** *Sternopriscus, Necterosoma, Chostonestes, Limnoxenus, Macrogyrus, Platynectes*	**Hydracarina** *(Piona, Oribatidae);* **Mollusca** *Angrobia, Glyptophysa (often in high numbers);* **Ephemeroptera** *(in low numbers) Cloeon, Tasmanocoenis;* **Trichoptera** *Triplectides, Hellyethira;* **Odonata** *Xanthagrion, Austrolestes, Hemicordulia;* **Diptera** *Stratiomyidae, Chironomidae (Cladotanytarsus, Tanytarsus);* **Coleoptera** *Sternopriscus, Necterosoma, Platynectes*	**Coleoptera** *Necterosoma*

	Very Good	Good	Fair	Poor	Very Poor
Attribute 5 Tolerant taxa	**Turbellaria**; **Nematoda; Oligochaeta; Amphipoda** *Austrochiltonia;* **Decapoda** *Paratya, Cherax;* **Diptera** *Simulium ornatipes, Culicidae (low numbers), Ceratopogonidae (Alluauodomyia, Forcipomyia, Nilobezzia, Ceratopogon, Bezzia, Culicoides), Chironomidae (Procladius, Paramerina, Parametriocnemus, Paralimnophyes, Cricotopus, Chironomus, Dicrotendipes);* **Hemiptera** *(low numbers of Microvelia, Micronecta, Agraptocorixa, Anisops, Enithares);* **Odonata** *Ischnura*	**Turbellaria**; **Nematoda; Oligochaeta; Amphipoda** *Austrochiltonia;* **Decapoda** *Paratya, Cherax;* **Diptera** *Simulium ornatipes, Culicidae, Stratiomyidae, Ceratopogonidae (Alluauodomyia, Forcipomyia, Nilobezzia, Ceratopogon, Bezzia, Culicoides), Chironomidae (Procladius, Paramerina, Parametriocnemus, Paralimnophyes, Cricotopus, Chironomus, Dicrotendipes);* **Hemiptera** *(moderate numbers of Microvelia, Micronecta, Agraptocorixa, Anisops, Enithares);* **Odonata** *Ischnura*	**Turbellaria**; **Nematoda; Oligochaeta; Mollusca** *Hydrobiidae;* **Amphipoda** *Austrochiltonia;* **Decapoda** *Paratya, Cherax;* **Collembola; Diptera** *Simulium ornatipes, Culicidae (often high numbers), Stratiomyidae, Ceratopogonidae (Bezzia, Culicoides), Chironomidae (Procladius, Paramerina, Parametriocnemus, Paralimnophyes, Cricotopus, Chironomus, Dicrotendipes);* **Hemiptera** *(often high numbers of Microvelia, Micronecta, Agraptocorixa, Anisops, Enithares);* **Odonata** *Ischnura*	**Turbellaria**; **Nematoda; Oligochaeta; Mollusca** *Hydrobiids;* **Amphipoda** *Austrochiltonia;* **Decapoda** *Paratya, Cherax;* **Collembola; Diptera** *Simulium ornatipes, Culicidae (often high numbers), Stratiomyidae, Ceratopogonidae (Bezzia, Culicoides), Chironomidae (Procladius, Paramerina, Parametriocnemus, Paralimnophyes, Cricotopus, Chironomus, Dicrotendipes);* **Hemiptera** *(often high numbers of Microvelia, Micronecta, Agraptocorixa, Anisops, Enithares);* **Odonata** *Ischnura*	**Oligochaeta** (often in high numbers)**; Amphipoda** *Austrochiltonia;* **Collembola**; **Diptera** *Culicidae, Stratiomyidae, Ceratopogonidae (Bezzia, Culicoides), Chironomidae (Procladius, Chironomus ;* the latter sometimes in large numbers)*;* **Hemiptera** *Micronecta, Anisops, Enithares*
Attribute 6 Non-endemic or introduced taxa	**Mollusca** *Physa* and *Potamopyrgus* in low numbers	**Mollusca** *Physa* and *Potamopyrgus* in low to moderate numbers	**Mollusca** *Physa* and *Potamopyrgus* in moderate to high numbers*;* **Fish** *Gambusia*	**Mollusca** *Physa* and *Potamopyrgus* in moderate to high numbers*;* **Fish** *Gambusia*	**Mollusca** *Physa;* **Fish** *Gambusia* (rarely present due to poor water quality)

Table 7 Condition ratings given by each panel member and final overall rating for each of the 41 sites monitored in the Eyre Peninsula, SA Murray–Darling Basin, and Adelaide and Mount Lofty Ranges NRM regions during 2015

Note: Site codes indicate the year sampled region followed by the site number. Refer to the EPA website <www.epa.sa.gov.au> for the site map coordinates and the site-based aquatic ecosystem condition reports.

[1] denotes the best condition sites based on prior knowledge of creeks and rivers in each region; these were not necessarily expected to represent the best condition sites that were being assessed during 2015.

[2] denotes the worst condition sites based on prior knowledge of creeks and rivers in each region; these were not necessarily expected to represent the worst condition sites that were being assessed during 2015.

[3] denotes the sites that were selected by each NRM/DEWNR to assist with Water Allocation Planning in each region.

[4] denotes the habitats at each site (eg dry sites, or if edge (E) or both edge and riffle (ER) aquatic habitats were present; results for each autumn and spring sampling period were separated by comma, so E,ER means edge was sampled in autumn and both edge and riffle were sampled in spring). NS = not sampled due to access problems.

Site code	Site name	Habitats[4]	Very Good	Good	Fair	Poor	Very Poor	Final rating
2015.WMLR02	[1]First Creek, flows to Tunkalilla Beach on the Fleurieu Peninsula	ER,ER	3					Very Good
2015.WMLR06	[3]First Creek, u/s waterfall	ER,ER	3					Very Good
2015.EMLR07	[3]Finniss River, near Yundi	E,E		3				Good
2015.EMLR11	Blackfellows Creek, near Kyeema Conservation Park	E,E		2	1			Good
2015.EMLR14	Ti Tree Creek, near McHarg Creek	ER,E		3				Good
2015.WMLR01	[1]First Creek, Waterfall Gully	ER,ER		3				Good
2015.WMLR08	[3]Callawonga Creek, Callawonga	ER,ER	1	2				Good
2015.WMLR09	[3]Sixth Creek, near Castambul	ER,ER		3				Good
2015.EP01	Tod River, downstream from Whites Flat	E,E			3			Fair
2015.EP02	Tod River, Koppio	E,E		1	2			Fair
2015.EP05	Tod River, near Yallunda Flat	E,E			3			Fair
2015.EP06	Tod River, near Tod River Reservoir	ER,ER			3			Fair
2015.EMLR03	[3]Bremer River, near Callington	ER,ER		1	2			Fair
2015.EMLR05	[3]Deep Creek, Deep Creek Road	E, Dry			3			Fair
2015.EMLR08	[3]Meadows Creek, near Meadows	E,E			2	1		Fair

Site code	Site name	Habitats[4]	Very Good	Good	Fair	Poor	Very Poor	Final rating
2015.EMLR10	Rodwell Creek, west from Woodchester	E,E			2	1		Fair
2015.EMLR13	Mount Barker Creek, Salem	E,E			3			Fair
2015.WMLR03	[2]South Para River, south-eastern edge of Gawler	Dry, Dry			3			Fair
2015.WMLR04	[2]Cox Creek, Piccadilly Valley	E,E			3			Fair
2015.WMLR05	[3]North Para River, u/s weir Chateau Yaldara	ER,ER			3			Fair
2015.WMLR07	[3]Brownhill Creek, d/s caravan park	ER,E			3			Fair
2015.WMLR11	[3]Aldgate Creek, Mylor	E,E			3			Fair
2015.WMLR14	Congeratinga Creek, near Second Valley	ER, Dry			3			Fair
2015.WMLR15	Torrens River, near Cudlee Creek junction	E,E			3			Fair
2015.WMLR16	Cudlee Creek, Torrens River junction	E,E			2	1		Fair
2015.EP03	Tod River, near North Shields	E,E			1	2		Poor
2015.EP07	Glengyle Creek, near Wangary	E,E				3		Poor
2015.EP08	Minniribbie Creek, Kellidie Bay Road	E,E				3		Poor
2015.EP09	Minniribbie Creek, near Kellidie Bay	NS,E				3		Poor
2015.EMLR01	[3]Paris Creek, south of Macclesfield	E,E				3		Poor
2015.EMLR02	[3]Gould Creek, Macclesfield	E, Dry				3		Poor
2015.EMLR04	[3]Nairne Creek, near Petwwod	E,E				3		Poor
2015.EMLR06	[3]Dry Creek, west from Monarto Zoo	Dry, Dry				3		Poor
2015.EMLR09	[3]Marne River, near Cambrai	E, Dry				3		Poor
2015.EMLR12	[3]Western Flat Creek, Mount Barker	E,E				3		Poor
2015.WMLR10	[3]Back Valley Creek, Back Valley	E,E				3		Poor
2015.WMLR12	[3]River Torrens, u/s Devon Rd	E, Dry				3		Poor
2015.WMLR13	[3]Pedler Creek, u/s Palm Valley	E, Dry				3		Poor

Site code	Site name	Habitats[4]	Very Good	Good	Fair	Poor	Very Poor	Final rating
2015.WMLR17	Gould Creek, near Little Para Reservoir	E, Dry				3		Poor
2015.EP04	Rock Valley Creek, near Koppio	E, Dry				1	2	Very Poor
2015.EP10	Driver River, near Verran	E,E				1	2	Very Poor

Table 9 Water chemistry and algal summary statistics from sites sampled from each region during 2015 (units given are mg/L unless otherwise indicated)

Eyre Peninsula

Parameter	Autumn (n=9 wet sites)				Spring (n=9 wet sites)				Autumn + Spring (n=18 wet sites both seasons combined)			
	mean	25th percentile	50th percentile	75th percentile	mean	25th percentile	50th percentile	75th percentile	mean	25th percentile	50th percentile	75th percentile
Chlorophyll *a* (ug/L)	7.7	2.8	3.8	7.5	12.8	5.4	10.9	13.3	10.2	3.5	5.5	11.6
Chlorophyll *b* (ug/L)	0.7	0.1	0.1	0.8	1.0	0.1	0.1	1.0	0.9	0.1	0.1	1.0
Oxidised N (NOx)	0.02	0.00	0.00	0.01	0.15	0.03	0.04	0.11	0.09	0.00	0.02	0.04
Total nitrogen	2.02	0.89	1.13	2.83	1.92	0.91	1.94	2.85	1.97	0.90	1.19	2.84
Total phosphorus	0.08	0.04	0.07	0.08	0.08	0.05	0.06	0.09	0.08	0.04	0.06	0.08
Water temperature (degrees Celcius)	13.5	12.1	13.3	14.6	20.1	17.6	20.0	22.0	16.8	13.4	16.6	19.7
Conductivity (uS/cm)	17,709	11,510	12,714	23,951	21,978	9,508	14,723	20,369	19,844	11,087	13,357	23,056
Dissolved oxygen	7.3	7.2	8.2	8.4	8.5	7.0	7.5	9.3	7.9	7.1	7.8	8.6
pH (pH units)	7.8	7.9	8.2	8.3	7.8	7.8	8.2	8.7	7.8	7.8	8.2	8.3

SA Murray–Darling

Parameter	Autumn (n=13 wet sites)				Spring (n=10 wet sites)				Autumn + Spring (n=23 wet sites both seasons combined)			
	mean	25th percentile	50th percentile	75th percentile	mean	25th percentile	50th percentile	75th percentile	mean	25th percentile	50th percentile	75th percentile
Chlorophyll *a* (ug/L)	14.5	1.6	3.5	12.4	9.0	3.6	5.1	10.5	12.1	2.2	4.6	11.7
Chlorophyll *b* (ug/L)	0.7	0.1	0.1	1.1	1.3	0.2	0.9	2.2	1.0	0.1	0.5	1.8
Oxidised N (NOx)	0.03	0.00	0.01	0.06	0.08	0.03	0.08	0.12	0.05	0.00	0.06	0.08
Total nitrogen	0.84	0.60	0.78	0.92	1.09	0.61	1.02	1.52	0.95	0.60	0.81	1.22
Total phosphorus	0.10	0.03	0.05	0.07	0.18	0.06	0.09	0.12	0.14	0.04	0.07	0.10
Water temperature (degrees Celcius)	12.1	12.1	12.2	12.3	17.8	14.6	18.2	19.6	14.6	12.2	12.8	16.5
Conductivity (uS/cm)	2,862	1,570	1,900	4,356	3,069	2,271	2,482	3,506	2,952	1,747	2,271	3,944
Dissolved oxygen	7.3	6.5	7.7	8.4	4.8	3.2	4.4	5.3	6.2	4.6	6.5	8.0
pH (pH units)	7.8	7.8	7.9	8.0	7.3	7.2	7.3	7.5	7.6	7.3	7.6	7.9

Adelaide and Mount Lofty Ranges

Parameter	Autumn (n=16 wet sites)				Spring (n=12 wet sites)				Autumn + Spring (n=28 wet sites both seasons combined)			
	mean	25th percentile	50th percentile	75th percentile	mean	25th percentile	50th percentile	75th percentile	mean	25th percentile	50th percentile	75th percentile
Chlorophyll *a* (ug/L)	1.9	0.2	0.9	2.8	1.8	0.8	1.2	2.5	1.9	0.2	0.9	2.1
Chlorophyll *b* (ug/L)	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Oxidised N (NOx)	0.15	0.00	0.01	0.06	0.06	0.04	0.05	0.09	0.11	0.01	0.04	0.07
Total nitrogen	1.00	0.44	0.69	0.93	0.63	0.31	0.44	0.88	0.84	0.37	0.53	0.88
Total phosphorus	0.09	0.02	0.03	0.03	0.09	0.01	0.05	0.07	0.09	0.02	0.03	0.05
Water temperature (degrees Celcius)	11.2	10.0	10.4	12.0	18.8	17.3	17.9	20.8	14.5	11.4	13.2	17.5
Conductivity (uS/cm)	1,096	427	1,046	1,663	1,180	542	751	1,025	1,132	444	742	1,381
Dissolved oxygen	7.9	6.3	6.5	9.3	6.6	3.4	7.4	9.5	7.3	5.9	7.9	9.4
pH (pH units)	7.9	7.7	7.9	8.1	7.7	7.5	7.8	8.0	7.8	7.6	7.9	8.0