Default Guideline Values (DGVs) for Aquatic Ecosystems of Hydrological Region 4 (Tasmanian Inland Waters)

August 2021

EPA TASMANIA
ENVIRONMENT PROTECTION AUTHORITY

Publishing Information

Citation:
Environment Protection Authority (2021) *Default Guideline Values (DGVs) for Aquatic Ecosystems of Hydrological Region 4 (Tasmanian Inland Waters,* Environment Protection Authority, Hobart, Tasmania.

Date:
August 2021

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ISBN-13:
978-1-74380-089-8

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Introduction

Water quality management, determination of water quality guideline values, and the setting of water quality objectives is guided by the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018* (ANZG 2018) and the *National Water Quality Management Strategy 1994* (NWQMS).

The *State Policy on Water Quality Management 1997 (*SPWQM*)* establishes a framework that is compatible and consistent with these national guidelines.

The default guideline values (DGVs) for aquatic ecosystems presented herein have been derived for the H4 Hydrological region in accordance with the NWQMS.

Protected Environmental Values (PEVs) – Community Values

As part of the implementation of the State Policy, protected environmental values for inland waters were determined through extensive stakeholder consultation and identification of community values and uses. The PEVs for inland waters were set for 22 areas on the basis of catchment boundary or municipal boundary. These are available via the EPA website.

The current PEVs for inland waters for the protection of aquatic ecosystems provide options for both pristine and modified systems:

A: Protection of Aquatic Ecosystems

(i) Pristine or nearly pristine ecosystems

(Having regard for the management objectives for nature recreation areas, conservation areas and game reserves outlined in Schedule 4 of the *National Parks and Wildlife Act 1970*.)

OR

(ii) Modified (not pristine) ecosystems

(i) from which edible fish, shellfish and crustacea are harvested

OR

(ii) from which edible fish, shellfish and/or crustacea are not harvested

B. Recreational Water Quality & Aesthetics

(i) Primary contact water quality (specify sites)

(ii) Secondary contact water quality

(iii) Aesthetic water quality

C. Raw Water for Drinking Water Supply

(i) Subject to coarse screening plus disinfection

D. Agricultural Water Uses

(i) Irrigation

(ii) Stock watering

E. Industrial Water Supply

That is, as a minimum, water quality management strategies should seek to provide water of a physical and chemical nature to support a pristine/modified aquatic ecosystem from which edible fish, crustacea and shellfish may be harvested; that is suitable as a raw water for drinking water supply subject to coarse screening plus disinfection; that is acceptable for irrigation and stock watering purposes; which will allow people to safely engage in primary contact recreation activities such as swimming (at specific sites, refer to Appendix C) and secondary contact recreation activities such as paddling or fishing in aesthetically pleasing waters; and which is suitable for industrial water supply, e.g., use by aquaculture (shellfish farms) in marine farming zones.

Default Guideline Values

Guideline values apply to key indicators and are numerical concentrations or descriptive statements recommended for the support and maintenance of the designated water use or value, i.e. the Protected Environmental Value (PEV).

Tasmania refers to the following national level guideline values for the relevant key indicators.

- Water Quality management Framework
- Toxicant DGVs in freshwater and marine water
- Water quality for primary industries
- Australian guidelines for water recycling
- Australian Drinking Water guidelines
- Guidelines for Managing Risks in Recreational water
- Cultural and spiritual values of waterways
- Food Standards

The primary focus within Tasmania has been the derivation of guideline values for Aquatic Ecosystems based on Tasmanian data for key indicators of interest. This is as the protection of aquatic ecosystems is a PEV common to all water types. In addition, the trigger values for aquatic ecosystems from the ANZECC 2000 water quality guidelines were based on either a very limited quantity of Tasmanian data or are based solely on data from other jurisdictions within the South-east zone.

Ecosystem Condition

The ANZG 2018 provides a framework for developing water quality guideline values based on the water type, health of aquatic ecosystems or ecosystem condition. Ecosystem condition can be viewed as a continuum ranging from natural to highly disturbed or artificial. The ANZG 2018 identifies three broad categories of ecosystem: High Ecological Value (HEV), Slightly to Moderately Disturbed (SMD) and Highly Disturbed (HD). To better characterise Tasmanian ecosystems the SMD category has been further divided into Slightly Modified Ecological Value (SMEV) and Moderately Disturbed (MD) (Figure 1).

High Ecological Value Ecosystems

High Ecological Value ecosystems (HEVs) are unmodified and highly valued ecosystems, typically (but not always) occurring in national parks, conservation reserves or in remote and/or inaccessible locations. Their ecological integrity is regarded as intact.

Slightly to Moderately Disturbed Ecosystems

Slightly to moderately disturbed ecosystems (SMD) are ecosystems where aquatic biological diversity may have been adversely affected ranging from a relatively small but measurable impact to a more significant one by human activity. The biological communities however remain in a healthy condition and ecosystem integrity is largely retained. This category has been further divided as follows

Slightly Modified Ecological Value

The Slightly Modified Ecological Value (SMEV) ecosystems are the least impacted ecosystems within the SMD category. Ecosystems within this category only show a slight deviation from natural condition.

Moderately Disturbed Ecosystems

These are ecosystems within the SMD category that have been subject to a moderate degree of departure from natural conditions.

Highly Disturbed Ecosystem

Highly disturbed ecosystems (HD) are measurably degraded ecosystems of lower ecological condition.

For the decision process and selection criteria for identifying ecosystem condition refer to the EPA document, Technical Guidance for Water Quality Objectives (WQOs) Setting for Tasmania.

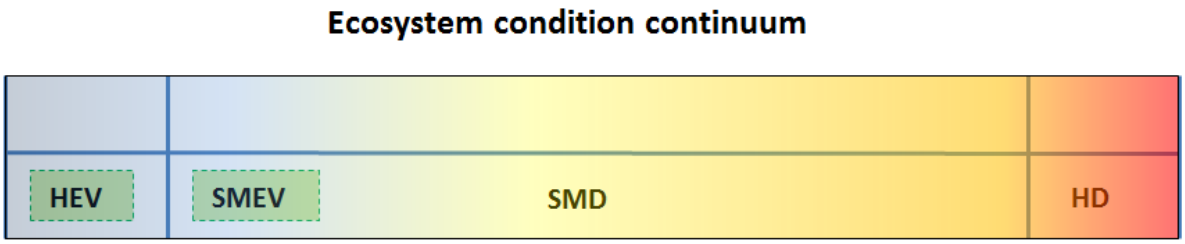

Figure 1. Ecosystem condition continuum showing HEV and SMEV reference categories.

Regionalisation of inland waters by Hydrological Region

The state water quality DGVs for aquatic ecosystems are based on data from across the entire state. To further refine this a hydrologcial regionalisation approach as been adotped that is based on river flow information (Hughes, 1987). The hydrologically distinct groupings (Figure 2) are largely determined by the characteristics outlined in Table 1 and associated catchments are listed in Table 2.

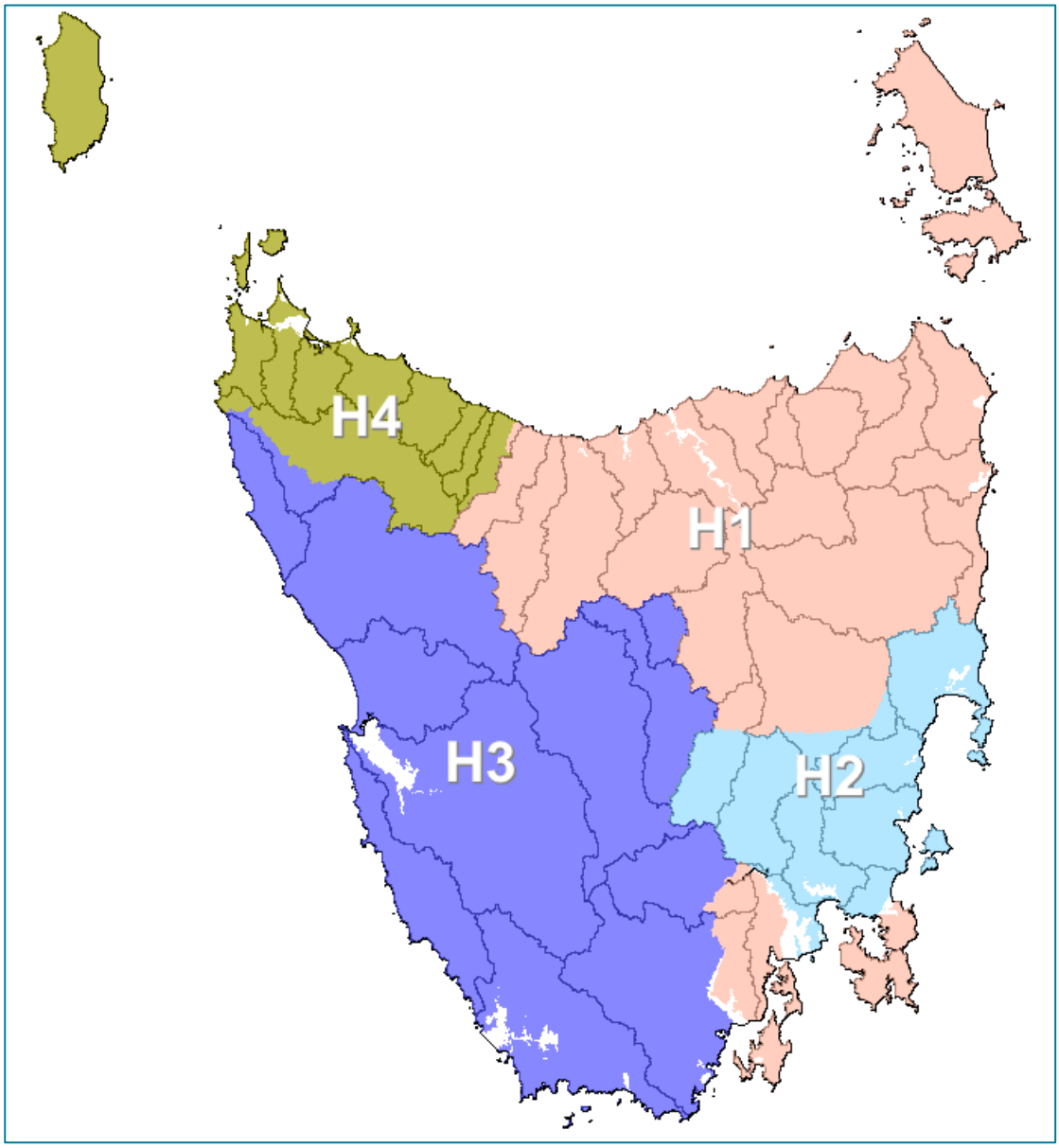

Figure 2. Hydrological regions (Hughes, 1987) and topographic catchments.

Table 1. Hydrological Regions in Tasmania

Hydrological Grouping	Descriptor
H1	Streams located inland from Tasmania's northern coast (including north east) characterised by moderately high runoff (762 mm), low CV annual flow and skewness (0.36 and 0.15, respectively), moderate to low CVs of monthly and monthly maximum flows (0.65 and 0.54, respectively) but high variability in low flows (CV = 0.91).
H2	Streams in the south-east corner of Tasmania characterised by low runoff (142 mm), high CV of annual flow (0.87), high skewness of annual flows (1.04) and high CVs of annual (0.87), monthly (0.70), maximum (0.67) and minimum flows (1.14).
H3	Streams in the south west Tasmania characterised by high runoff (1347 mm), very low CV of annual flow (0.23) and low skewness (0.46) and low CVs of monthly (0.49), maximum (0.44) and minimum (0.67) flows.
H4	Streams typically located on the north-western coastal zone of Tasmania. intermediate runoff values (mean = 410 mm), moderate CV of annual flows (0.52), moderate skewness of annual flows (0.75), comparatively high CVs of monthly (0.75), maximum (0.66) and minimum (1.19) flows , low variability of peak flows (0.29) but high variability of low flows (0.66).

Where CV is the coefficient of variability.

Table 2. Hydrological region and associated catchments

Hydrological Region	Catchment
Hydrological Region 1 (H1)	The Leven, Mersey, Meander, Rubicon, Tamar Estuary, Brumbys-Lake, South Esk, North Esk, Pipers, Little Forester, Great Forester-Brid, Ringarooma, Boobyalla-Tomahawk, George, Great Musselroe-Ansons, and Scamander-Douglas catchments are entirely within the H1 hydrological region. The Macquarie, Tasman, Huon, Clyde, Lower Derwent and Derwent Estuary-Bruny catchments are deemed to be partly within the H1 and partly within the H3 or H2 Hydrological regions.
Hydrological Region 2 (H2)	The Swan-Apsley, Little Swanport, Prosser, Pitt water-Coal and Jordan catchments are entirely within the hydrological region. The Tasman, Derwent Estuary – Bruny, Clyde and Macquarie catchments are deemed to be partly within the H2 and partly within the H1 Hydrological region. The Lower Derwent catchment is predominantly within the H3 region, but also has river sections that have been deemed to belong to the H1 and H2 hydrological regions. The river sections of the Lower Derwent catchment belonging to the H2 hydrological region are between Upper Dromedary and Bridgewater.
Hydrological Region 3 (H3)	The Ouse, Great Lake, Upper Derwent, Gordon-Franklin, Port Davey, Wanderer-Giblin, King-Henty and Pieman catchments are entirely within the hydrological region. The Huon and Lower Derwent catchments are predominately within H3 but also partly within the H1 hydrological region. While the Arthur catchment is only partly within H3 and predominantly within the H4 hydrological region.
Hydrological Region 4 (H4)	The Blythe, Emu, Cam, Inglis-Flowerdale, Black-Detention, Duck, Montagu, Welcome and King Island catchments are entirely within the hydrological region. The Arthur catchment is deemed to be predominantly within the H4 and only partly within the H3 hydrological region.

Deriving DGVs for Hydrological region aquatic ecosystems

The DGVs for aquatic ecosystems of Hydrolical Region 4 are based on data from 25 sites. Of these 8 sites were HEV ecosystem category and 17 were SMD ecosystem category. A suite of biological indicators has also been used to derive biological DGVs for the HEV and SMD ecosystem categories. Biological information was used from 26 sites. Of these 17 sites were HEV ecosystem category and 9 were SMD ecosystem category.

The parameters or indicators measured at a site are dependent on the water type and the question being asked by the monitoring program. For inland water the indicators that were widely monitored (spatially and temporally) were selected for the derivation of DGVs for aquatic ecosystems (Table 3.).

Table 3. Indicators for which DGVs were derived for inland waters

Water Type	Indicator
Inland	• Physico-chemical: Dissolved Oxygen, Conductivity pH, Turbidity and, Water Temperature. • Nutrients: TAN (NH_3 and NH_4^+), Nitrate, Nitrite, Total Nitrogen, Dissolved Reactive Phosphorus, Total Phosphorus and, Total Suspended Solids (TSS). • Biological: AUSRIVSA Band, OE50, OE50Signal, Signal Index, Taxon Diversity, EPT Diversity, and Macroinvertebrate Composition, Fish O/E, Fish O/P, Proportion native fish abundance, proportion native fish species, proportion native biomass, Chlorophyll a, algal cover and riparian shading*

*For details of the biological indicators for inland waters Refer to Appendix B.

Where possible water quality data collected at times of no flow or during times of flood (over bank full) have been excluded in the derivation of the water quality DGVs. On this basis it can be taken that the WQ DGVs represent base flow conditions**,** i.e. flow conditions that occur 98 percent of the time within waterways. For the decision process and selection criteria for identifying flow conditions refer to the EPA document, Technical Guidance for Water Quality Objectives (WQOs) Setting for Tasmania.

The minimum sample number required to determine percentile values with at least 95% confidence for WQ DGVs are as follows: 6 samples for 50th percentile; 14 samples for 20th and 80th percentiles; 29 samples for 10th and 90th percentiles; and 35 samples for 5th and 95th percentiles. In instances where there is insufficient data for a given key indicator the national WQ DGVs can be used. For biological indicators a minimum of six combined season outputs have been used to generate percentile values to provide a level of statistical robustness for biological DGVs.

HEV DGVs for aquatic ecosystems of Hydrological Region 4

The HEV water quality DGVs (Tables 4 to 8 shaded values) have been derived from 8 HEV sites.

Table 4 Full year

Parameter	5th %ile	10th %ile	20th %ile	Median	80th %ile	90th %ile	95th %ile	Sample Number
Dissolved Oxygen mg/L	6.9	7.8	8.7	9.9	10.9	11.4	11.9	439
Dissolved Oxygen % Saturation	56.2	65.7	78.4	94.7	100.4	102.6	106.7	68
Field Cond @ TRef25 µS/cm	58.2	66.5	75.0	101.6	178.6	357.3	462.6	428
pH field - sensor TC	4.6	4.8	5.3	6.6	7.2	7.4	7.7	439
Turbidity NTU	1.6	1.9	2.4	4.1	8.8	15.0	21.4	447
Temperature (Celsius)	6.8	7.6	8.7	11.0	14.0	15.9	16.6	448
TAN as N mg/l	0.014	0.017	0.021	0.033	0.051	0.071	0.096	38
Nitrate as N mg/l	0.021	0.025	0.042	0.082	0.136	0.173	0.269	54
Nitrite as N mg/l	0.001	0.001	0.002	0.004	0.008	0.010	0.010	38
Total Nitrogen as N mg/l	0.025	0.025	0.197	0.549	0.706	0.842	0.991	95
Phosphorus, Dissolved Reactive as P mg/l	0.001	0.001	0.002	0.003	0.004	0.004	0.005	38
Total Phosphorus as P mg/l	0.006	0.007	0.009	0.013	0.025	0.069	0.102	93
Total Suspended Solids (1.5µm) mg/L	5.000	5.000	5.000	5.000	5.000	5.000	5.000	15
Total Suspended Solids (0.45µm) mg/L*	0.500	0.500	0.500	0.500	3.000	7.000	10.150	358

* State derived values, TAN=Total Ammonia Nitrogen (NH_3 and NH_4^+)

Table 5 Summer

Parameter	5th %ile	10th %ile	20th %ile	Median	80th %ile	90th %ile	95th %ile	Sample Number
Dissolved Oxygen mg/L	5.7	6.8	7.6	9.1	10.0	10.2	10.7	117
Dissolved Oxygen % Saturation	58.0	73.9	89.7	98.2	104.5	111.0	114.9	16
Field Cond @ TRef25 µS/cm	55.1	61.0	75.0	100.9	172.3	352.0	474.5	111
pH field - sensor TC	4.8	5.0	5.6	6.9	7.4	7.7	7.8	117
Turbidity NTU	1.5	1.7	2.3	3.8	7.1	11.3	15.5	117
Temperature (Celsius)	11.0	11.6	12.7	14.5	16.6	17.5	18.3	117
TAN as N mg/l	0.008	0.013	0.019	0.025	0.048	0.055	0.056	8
Nitrate as N mg/l	0.060	0.075	0.081	0.127	0.172	0.193	0.253	14
Nitrite as N mg/l	0.001	0.001	0.001	0.004	0.007	0.007	0.007	8
Total Nitrogen as N mg/l	0.025	0.047	0.195	0.589	0.662	0.764	0.792	25
Phosphorus, Dissolved Reactive as P mg/l	0.001	0.002	0.002	0.003	0.005	0.005	0.006	8
Total Phosphorus as P mg/l	0.010	0.010	0.011	0.018	0.024	0.025	0.077	25
Total Suspended Solids (1.5µm) mg/L	5.000	5.000	5.000	5.000	5.000	5.000	5.000	4
Total Suspended Solids (0.45µm) mg/L*	0.500	0.500	0.500	0.500	3.000	7.000	8.000	101

* State derived values, TAN=Total Ammonia Nitrogen (NH_3 and NH_4^+)

Table 6 Autumn

Parameter	5th %ile	10th %ile	20th %ile	Median	80th %ile	90th %ile	95th %ile	Sample Number
Dissolved Oxygen mg/L	6.4	7.4	8.3	9.8	10.6	11.2	11.8	109
Dissolved Oxygen % Saturation	37.4	53.1	64.2	92.6	101.3	103.7	105.1	16
Field Cond @ TRef25 µS/cm	61.0	68.8	84.8	111.4	187.6	485.7	507.1	112
pH field - sensor TC	5.0	5.2	5.6	6.8	7.2	7.5	7.6	114
Turbidity NTU	1.4	1.8	2.3	4.0	7.3	12.1	22.0	118
Temperature (Celsius)	8.0	8.6	9.2	11.1	13.1	13.8	15.3	118
TAN as N mg/l	0.017	0.020	0.025	0.037	0.070	0.088	0.136	10
Nitrate as N mg/l	0.016	0.022	0.026	0.077	0.130	0.208	0.289	14
Nitrite as N mg/l	0.001	0.002	0.003	0.004	0.007	0.009	0.010	10
Total Nitrogen as N mg/l	0.025	0.095	0.133	0.540	0.643	0.774	0.842	32
Phosphorus, Dissolved Reactive as P mg/l	0.001	0.001	0.002	0.003	0.004	0.004	0.005	10
Total Phosphorus as P mg/l	0.007	0.008	0.009	0.014	0.029	0.047	0.106	32
Total Suspended Solids (1.5µm) mg/L	5.000	5.000	5.000	5.000	5.000	5.000	5.000	3
Total Suspended Solids (0.45µm) mg/L*	0.500	0.500	0.500	0.500	5.000	7.600	17.300	95

* State derived values, TAN=Total Ammonia Nitrogen (NH_3 and NH_4^+)

Table 7 Winter

Parameter	5th %ile	10th %ile	20th %ile	Median	80th %ile	90th %ile	95th %ile	Sample Number
Dissolved Oxygen mg/L	8.6	9.4	9.7	10.6	11.6	11.9	12.1	113
Dissolved Oxygen % Saturation	69.5	73.4	77.0	89.6	95.3	97.4	98.5	18
Field Cond @ TRef25 µS/cm	64.2	70.1	75.7	97.9	216.6	330.1	360.3	108
pH field - sensor TC	4.3	4.5	4.8	6.2	6.8	7.1	7.2	113
Turbidity NTU	1.6	2.0	2.7	4.2	11.0	17.8	29.7	112
Temperature (Celsius)	5.6	6.5	7.0	8.6	9.9	10.6	11.2	113
TAN as N mg/l	0.013	0.017	0.021	0.033	0.055	0.089	0.113	11
Nitrate as N mg/l	0.022	0.027	0.036	0.054	0.091	0.128	0.129	11
Nitrite as N mg/l	0.001	0.001	0.002	0.003	0.008	0.010	0.012	11
Total Nitrogen as N mg/l	0.025	0.025	0.100	0.600	0.825	0.952	1.158	23
Phosphorus, Dissolved Reactive as P mg/l	0.002	0.002	0.002	0.002	0.004	0.004	0.004	11
Total Phosphorus as P mg/l	0.004	0.005	0.006	0.010	0.065	0.097	0.106	21
Total Suspended Solids (1.5µm) mg/L	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5
Total Suspended Solids (0.45µm) mg/L*	0.500	0.500	0.500	0.500	3.000	4.700	8.350	74

* State derived values, TAN=Total Ammonia Nitrogen (NH_3 and NH_4^+)

Table 8 Spring

Parameter	5th %ile	10th %ile	20th %ile	Median	80th %ile	90th %ile	95th %ile	Sample Number
Dissolved Oxygen mg/L	8.2	8.5	8.9	10.3	10.9	11.4	12.0	100
Dissolved Oxygen % Saturation	58.0	72.7	79.7	95.1	98.5	100.6	101.5	18
Field Cond @ TRef25 µS/cm	54.0	61.5	72.3	93.0	170.8	313.0	373.6	97
pH field - sensor TC	4.7	4.8	5.2	6.4	7.0	7.3	7.6	95
Turbidity NTU	1.7	2.2	2.7	4.2	11.7	15.6	19.6	100
Temperature (Celsius)	7.2	7.8	8.9	10.7	12.6	14.3	15.5	100
TAN as N mg/l	0.022	0.023	0.024	0.031	0.043	0.044	0.044	9
Nitrate as N mg/l	0.023	0.032	0.046	0.067	0.087	0.131	0.251	15
Nitrite as N mg/l	0.003	0.003	0.004	0.007	0.009	0.010	0.011	9
Total Nitrogen as N mg/l	0.274	0.395	0.496	0.533	0.717	0.975	1.250	15
Phosphorus, Dissolved Reactive as P mg/l	0.001	0.002	0.002	0.003	0.004	0.004	0.005	9
Total Phosphorus as P mg/l	0.004	0.005	0.007	0.012	0.018	0.025	0.084	15
Total Suspended Solids (1.5µm) mg/L	5.000	5.000	5.000	5.000	5.000	5.000	5.000	3
Total Suspended Solids (0.45µm) mg/L*	0.500	0.500	0.500	0.500	3.000	6.000	9.650	88

* State derived values, TAN=Total Ammonia Nitrogen (NH_3 and NH_4^+)

The HEV biological DGVs detailed in Table 9 have been derived from 17 HEV sites.

Table 9 Data Summary and biological DGVs (shaded) for HEV ecosystems of Hydrological Region 4

Parameter	5th %ile	10th %ile	20th %ile	Median	80th %ile	90th %ile	95th %ile	Sample Number
AUSRIVAS Band#	B	A	A	A	X	X	X	37
OE50#	0.85	0.88	0.92	1.05	1.13	1.14	1.15	37
OE50Signal#	0.96	0.97	0.98	0.99	1.00	1.01	1.02	37
Signal Index	5.7	5.8	5.9	6.2	6.4	6.4	6.5	37
Taxon Diversity	20	22	23	26	29	32	33	37
EPT Diversity	7	7	8	11	13	13	14	37
Macroinvertebrate composition	0.30	0.33	0.36	0.40	0.44	0.46	0.50	37

Based on combined season AUSRIVAS outputs

SMD DGVs for aquatic ecosystems of Hydrological Region 4

The SMD water quality DGVs (Tables 10 to 14 shaded values) have been derived from 17 SMEV sites.

Table 10 Full year

Parameter	5th %ile	10th %ile	20th %ile	Median	80th %ile	90th %ile	95th %ile	Sample Number
Dissolved Oxygen mg/L	7.9	8.4	9.0	10.1	10.9	11.4	11.8	656
Dissolved Oxygen % Saturation	80.2	83.0	88.0	94.2	100.0	105.0	114.2	312
Field Cond @ TRef25 µS/cm	46.0	52.7	64.0	101.6	144.0	174.8	221.0	662
pH field - sensor TC	5.7	6.1	6.4	6.8	7.2	7.4	7.6	652
Turbidity NTU	1.7	2.2	3.0	4.9	8.6	11.8	16.2	666
Temperature (Celsius)	7.0	7.8	8.8	11.5	15.1	16.7	18.4	666
TAN as N mg/l	0.004	0.006	0.009	0.015	0.038	0.063	0.080	212
Nitrate as N mg/l	0.001	0.006	0.018	0.052	0.187	0.317	0.389	225
Nitrite as N mg/l	0.001	0.001	0.001	0.001	0.004	0.005	0.006	212
Total Nitrogen as N mg/l	0.098	0.129	0.191	0.421	0.663	0.832	0.943	248
Phosphorus, Dissolved Reactive as P mg/l	0.001	0.001	0.002	0.003	0.005	0.006	0.008	212
Total Phosphorus as P mg/l	0.005	0.007	0.009	0.014	0.025	0.038	0.053	248
Total Suspended Solids (1.5µm) mg/L	5.000	5.000	5.000	5.000	5.000	11.100	20.000	60
Total Suspended Solids (0.45µm) mg/L*	0.500	0.500	0.500	3.000	11.000	20.700	33.750	134

* State derived values, TAN=Total Ammonia Nitrogen (NH_3 and NH_4^+)

Table 11 Summer

Parameter	5th %ile	10th %ile	20th %ile	Median	80th %ile	90th %ile	95th %ile	Sample Number
Dissolved Oxygen mg/L	7.2	7.9	8.3	9.2	10.0	10.5	11.3	161
Dissolved Oxygen % Saturation	80.3	82.1	85.2	94.5	105.0	114.9	126.8	85
Field Cond @ TRef25 µS/cm	55.0	60.4	68.8	105.0	145.0	171.0	200.0	161
pH field - sensor TC	5.9	6.4	6.6	6.9	7.2	7.4	7.5	160
Turbidity NTU	1.3	1.9	2.7	4.4	6.4	8.4	10.0	161
Temperature (Celsius)	11.7	12.3	13.4	15.5	18.4	20.6	22.1	161
TAN as N mg/l	0.005	0.006	0.010	0.018	0.030	0.051	0.062	51
Nitrate as N mg/l	0.001	0.001	0.006	0.029	0.136	0.229	0.275	56
Nitrite as N mg/l	0.001	0.001	0.001	0.002	0.004	0.005	0.006	51
Total Nitrogen as N mg/l	0.114	0.149	0.217	0.449	0.591	0.712	0.896	61
Phosphorus, Dissolved Reactive as P mg/l	0.001	0.001	0.002	0.004	0.005	0.006	0.006	51
Total Phosphorus as P mg/l	0.005	0.007	0.009	0.016	0.024	0.034	0.038	61
Total Suspended Solids (1.5µm) mg/L	5.000	5.000	5.000	5.000	5.000	5.000	6.500	15
Total Suspended Solids (0.45µm) mg/L*	0.650	1.600	3.000	9.000	15.200	20.400	42.900	27

* State derived values, TAN=Total Ammonia Nitrogen (NH_3 and NH_4^+)

Table 12 Autumn

Parameter	5th %ile	10th %ile	20th %ile	Median	80th %ile	90th %ile	95th %ile	Sample Number
Dissolved Oxygen mg/L	7.9	8.6	9.2	10.2	10.8	11.1	11.7	167
Dissolved Oxygen % Saturation	81.7	84.1	88.1	93.1	99.8	103.2	113.8	79
Field Cond @ TRef25 µS/cm	51.9	62.0	74.1	108.0	155.3	179.6	210.4	173
pH field - sensor TC	6.1	6.2	6.5	7.0	7.4	7.5	7.6	167
Turbidity NTU	1.6	2.0	2.8	4.3	7.8	10.8	21.5	173
Temperature (Celsius)	7.8	8.8	9.3	11.3	14.1	15.6	16.4	173
TAN as N mg/l	0.004	0.007	0.010	0.016	0.044	0.062	0.067	57
Nitrate as N mg/l	0.001	0.005	0.009	0.038	0.125	0.170	0.199	59
Nitrite as N mg/l	0.001	0.001	0.001	0.001	0.003	0.004	0.005	57
Total Nitrogen as N mg/l	0.025	0.091	0.158	0.373	0.525	0.664	0.728	73
Phosphorus, Dissolved Reactive as P mg/l	0.001	0.001	0.001	0.003	0.005	0.005	0.006	57
Total Phosphorus as P mg/l	0.007	0.008	0.010	0.016	0.027	0.050	0.128	73
Total Suspended Solids (1.5µm) mg/L	5.000	5.000	5.000	5.000	5.000	5.000	11.750	12
Total Suspended Solids (0.45µm) mg/L*	0.500	0.500	0.500	5.000	12.000	16.600	25.650	28

* State derived values, TAN=Total Ammonia Nitrogen (NH_3 and NH_4^+)

Table 13 Winter

Parameter	5th %ile	10th %ile	20th %ile	Median	80th %ile	90th %ile	95th %ile	Sample Number
Dissolved Oxygen mg/L	8.6	9.7	10.0	10.8	11.4	11.8	12.5	165
Dissolved Oxygen % Saturation	68.5	82.6	86.8	93.5	98.0	102.4	106.9	66
Field Cond @ TRef25 µS/cm	38.7	44.0	56.0	88.1	143.9	174.6	341.5	162
pH field - sensor TC	5.3	5.7	6.2	6.7	7.0	7.2	7.4	164
Turbidity NTU	2.3	2.9	3.6	6.0	10.9	14.5	16.3	165
Temperature (Celsius)	5.5	6.3	7.1	8.5	9.9	10.7	11.4	165
TAN as N mg/l	0.006	0.007	0.008	0.013	0.023	0.043	0.076	49
Nitrate as N mg/l	0.019	0.022	0.039	0.090	0.353	0.418	0.464	50
Nitrite as N mg/l	0.001	0.001	0.001	0.001	0.003	0.005	0.007	49
Total Nitrogen as N mg/l	0.113	0.150	0.201	0.521	0.742	0.913	0.956	54
Phosphorus, Dissolved Reactive as P mg/l	0.001	0.001	0.002	0.003	0.005	0.009	0.017	49
Total Phosphorus as P mg/l	0.003	0.005	0.007	0.012	0.026	0.037	0.050	54
Total Suspended Solids (1.5µm) mg/L	5.000	5.000	5.000	5.000	8.000	13.200	19.400	23
Total Suspended Solids (0.45µm) mg/L*	0.500	0.500	0.500	3.000	7.000	15.200	22.100	39

* State derived values, TAN=Total Ammonia Nitrogen (NH_3 and NH_4^+)

Table 14 Spring

Parameter	5th %ile	10th %ile	20th %ile	Median	80th %ile	90th %ile	95th %ile	Sample Number
Dissolved Oxygen mg/L	8.2	8.7	9.2	10.1	10.8	11.2	11.5	163
Dissolved Oxygen % Saturation	83.1	86.3	90.7	95.4	100.0	101.4	103.0	82
Field Cond @ TRef25 µS/cm	43.2	49.2	59.1	102.7	135.3	164.8	266.5	166
pH field - sensor TC	5.8	6.0	6.3	6.7	7.2	7.5	7.7	161
Turbidity NTU	1.7	2.3	3.1	5.1	10.0	12.6	18.0	167
Temperature (Celsius)	8.3	8.8	9.7	11.8	14.0	15.5	16.6	167
TAN as N mg/l	0.004	0.007	0.009	0.013	0.055	0.079	0.103	55
Nitrate as N mg/l	0.017	0.021	0.028	0.077	0.299	0.358	0.434	60
Nitrite as N mg/l	0.001	0.001	0.001	0.001	0.004	0.005	0.005	55
Total Nitrogen as N mg/l	0.126	0.157	0.190	0.426	0.780	0.892	1.080	60
Phosphorus, Dissolved Reactive as P mg/l	0.001	0.001	0.002	0.003	0.005	0.007	0.008	55
Total Phosphorus as P mg/l	0.008	0.009	0.011	0.014	0.025	0.033	0.041	60
Total Suspended Solids (1.5µm) mg/L	5.000	5.000	5.000	5.000	11.200	12.900	16.950	10
Total Suspended Solids (0.45µm) mg/L*	0.500	0.500	0.500	2.250	8.200	22.100	41.400	40

* State derived values, TAN=Total Ammonia Nitrogen (NH_3 and NH_4^+)

The SMD biological DGVs detailed in Table 15 have been derived from 9 SMEV sites.

Table 15 Data Summary and biological DGVs (shaded) for SMD ecosystems of Hydrological Region 4

Parameter	5th %ile	10th %ile	20th %ile	Median	80th %ile	90th %ile	95th %ile	Sample Number
AUSRIVAS Band#	B	B	A	A	A	A	X	42
OE50#	0.84	0.84	0.90	1.03	1.06	1.09	1.15	42
OE50Signal#	0.92	0.93	0.95	0.97	1.00	1.01	1.02	42
Signal Index	5.6	5.7	5.8	6.0	6.3	6.4	6.4	42
Taxon Diversity	21	23	24	27	30	31	32	42
EPT Diversity	8	9	10	11	13	13	13	42
Macroinvertebrate composition	0.33	0.36	0.38	0.42	0.44	0.47	0.50	42

Based on combined season AUSRIVAS outputs

The SMD DGVs may represent aspirational DGVs for moderately disturbed ecosystems but apply when site-specific guideline values consistent with the NWQMS are not available.

A summary of the HEV and SMD DGVs from Table 4 to Table 15 are provided in Appendix A.

Appendix A: DGVs summary for aquatic ecosystems of Hydrological Region 4.

HEV	Physico-chemical indicators and water quality DGVs for Aquatic Ecosystems																	
	DO (mg/L)		DO (% sat)		Cond	pH		Turb	Temp (°C)		TAN as N	NO_3 as N	NO_2 as N	Total N as N	DRP as P	Total P as P	TSS (1.5 µm)	TSS* (0.45 µm)
	lower	upper	lower	upper	(µs/cm)	lower	upper	NTU	lower	upper	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Annual	8.7	10.9	78.4	100.4	178.6	5.3	7.2	8.8	8.7	14.0	0.051	0.136	0.008	0.706	0.004	0.025	5.000	3.000
Summer	7.6	10.0	89.7	104.5	172.3	5.6	7.4	7.1	12.7	16.6	0.048~	0.172	0.007~	0.662	0.005~	0.024	5.000~	3.000
Autumn	8.3	10.6	64.2	101.3	187.6	5.6	7.2	7.3	9.2	13.1	0.070~	0.130	0.007~	0.643	0.004~	0.029	5.000~	5.000
Winter	9.7	11.6	77.0	95.3	216.6	4.8	6.8	11.0	7.0	9.9	0.055~	0.091~	0.008~	0.825	0.004~	0.065	5.000~	3.000
Spring	8.9	10.9	79.7	98.5	170.8	5.2	7.0	11.7	8.9	12.6	0.043~	0.087	0.009~	0.717	0.004~	0.018	5.000~	3.000

NB: DO (dissolved oxygen), Cond (electrical conductivity), Turb (turbidity), TAN (total ammonia nitrogen (NH_3 and NH_4^+)), DRP (dissolved reactive phosphorus), TSS (total suspended solids) filtered through, e.g., 1.5 µm, ~ <95% Confidence, * State derived values. Figures shown above are based on data from 8 HEV sites.

SMD	Physico-chemical indicators and water quality DGVs for Aquatic Ecosystems																	
	DO (mg/L)		DO (% sat)		Cond	pH		Turb	Temp (°C)		TAN as N	NO_3 as N	NO_2 as N	Total N as N	DRP as P	Total P as P	TSS (1.5 µm)	TSS* (0.45 µm)
	lower	upper	lower	upper	(µs/cm)	lower	upper	NTU	lower	upper	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Annual	9.0	10.9	88.0	100.0	144.0	6.4	7.2	8.6	8.8	15.1	0.038	0.187	0.004	0.663	0.005	0.025	5.000	11.000
Summer	8.3	10.0	85.2	105.0	145.0	6.6	7.2	6.4	13.4	18.4	0.030	0.136	0.004	0.591	0.005	0.024	5.000	15.200
Autumn	9.2	10.8	88.1	99.8	155.3	6.5	7.4	7.8	9.3	14.1	0.044	0.125	0.003	0.525	0.005	0.027	5.000~	12.000
Winter	10.0	11.4	86.8	98.0	143.9	6.2	7.0	10.9	7.1	9.9	0.023	0.353	0.003	0.742	0.005	0.026	8.000	7.000
Spring	9.2	10.8	90.7	100.0	135.3	6.3	7.2	10.0	9.7	14.0	0.055	0.299	0.004	0.780	0.005	0.025	11.20~	8.200

NB: DO (dissolved oxygen), Cond (electrical conductivity), Turb (turbidity), TAN (total ammonia nitrogen (NH_3 and NH_4+)), DRP (dissolved reactive phosphorus), TSS (total suspended solids) filtered through, e.g., 1.5 µm, ~ <95% Confidence, * State derived values. Figures shown above are based on data from 17 SMEV sites.

Biological Condition	Biological indicators and biological DGVs for Aquatic Ecosystems													
	AUSIVAS band		OE50		OE50 Signal		Signal Index		Taxon Diversity		EPT Diversity		Macroinvertebrate Composition	
	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper	lower	upper
HEV	A	X	0.92	1.13	0.98	1.00	5.9	6.4	23	29	8	13	0.36	0.44
SMD	A	A	0.90	1.06	0.95	1.00	5.8	6.3	24	30	10	13	0.38	0.44

Figures shown above are based on data from 17 HEV and 9 SMEV sites.

Appendix B: Biological Indicators for Inland waters

The following benthic macro-invertebrates indices are part of the rapid biological assessment approach. Those noted with "*" are based on combined season riffle AUSRIVAS outputs.

Parameter Name	Description
AUSRIVAS Band *	Band allocation from combined season riffle AUSRIVAS model letter score.
EPT Diversity	number of Ephemeroptera, Plecoptera and Trichoptera families observed in samples for combined season riffle analysis
Macroinvertebrate composition	Proportion of Ephemeroptera, Plecoptera and Trichoptera families observed in samples for combined season riffle analysis
OE50*	Observed versus expected ratio from combined season riffle AUSRIVAS model
OE50Signal *	Sensitivity score for expected taxa from combined season riffle AUSRIVAS model
Signal Index	Average signal score of families/taxa observed in samples for combined season riffle analysis
Taxon Diversity	number of families/taxa observed in samples for combined season riffle analysis
Fish Observed/Expected ratio	Comparison of native fish species predicted to occur in a stream reach by CFEV with species actually observed in the reach by electrofishing
Fish Observed/Predicted ratio	Comparison of native fish species predicted to have occurred (pre-European) in a CFEV sub-catchment with native species observed in the sub-catchment by electrofishing
Proportion native fish abundance	Proportion of individual fish electrofished at a site that are native species
Proportion native fish species	Proportion of fish species electrofished at a site that are native species
Proportion native biomass	Proportion of total biomass electrofished at a site comprised of native species

SIGNAL Index

The SIGNAL (Stream Invertebrate Grade Number Average Level) Index for a pair of samples is calculated by averaging the pollution sensitivity grade numbers (signal scores) of the 'families' collected. Pollution sensitivity grade numbers range from 10 for the most sensitive taxa to 1 for the most tolerant taxa (Chessman 2003). The resultant SIGNAL index provides an indication of water pollution impacts.

Signal Score	Water quality
>6	Excellent
5-5.9	Clean water
4-4.9	Mild pollution
3-3.9	Moderate pollution
<3	Severe pollution

Derived guidelines for Biological Indicators

Information from the Tasmanian River Condition Index (TRCI) project has been incorporated into the biological DGVs in order to provide guideline values for key biological indicators that are not related to AUSRIVAS assessments, but relate to invertebrate abundance, native fish and algae. The biological indicators and associated values for HEV and SMD ecosystems are outlined in the following section.

Macroinvertebrate abundance

For benthic macroinvertebrate abundance a default total abundance count range of 700-4400 individuals/m^2 has been derived from Tasmanian River Condition Index for moderate to good condition category. This can be applied to HEV and SMD ecosystems.

Native fish indicators

The Tasmanian River Condition Index (TRCI) native fish indicators have been adopted, as follows; ratio of observed to expected fish for the river reach, ratio of observed to predicted fish for the sub-catchment, native fish abundance, native fish biomass, and proportion of fish species that are native.

For HEV ecosystems a default value of greater than (>)0.59 has been adopted for the observed/expected (O/E) biometric. For the observed/predicted (O/P) biometric a default value of >0.29 has been adopted. For native fish abundance, native fish biomass and proportion of native fish species a default value of >0.7 has been adopted. The default ranges for HEV ecosystems have been derived from the good fish condition category.

For SMD ecosystems a default score range of 0.29-0.59 has been adopted for the observed/expected (O/E) and 0.14-0.29 observed/predicted (O/P) biometrics. For native fish abundance and native fish biomass a default range of 0.30-0.69 has been adopted, whilst for proportion of native fish species a default score range of 0.2 to 0.69 has been adopted. The default ranges have been derived from the moderate fish condition category.

Algal indicators

The Tasmanian River Condition Index (TRCI) algal indicators have been adopted as follows; Chlorophyll-a biomass, percent riparian shading, and percent algal cover.

For HEV ecosystems, chlorophyll-a default biomass values of less than (<)4 mg/m^2 of rock surface under greater than (>)80% riparian shading, <6 mg/m^2 of rock surface under 60-80% riparian shading, and <15 mg/m^2 of rock surface under <60% riparian shading have been derived from the TRCI low category for algal biomass. An algal cover of <80% for rock substrate has been adopted as the default value for algal cover based on the low to moderate category for algal cover.

For SMD ecosystems, chlorophyll-a default biomass values <20 mg/m^2 of rock surface under >80% riparian shading, <25 mg/m^2 of rock surface under 60-80% riparian shading, and <60 mg/m^2 of rock surface under <60% riparian shading have been derived from the TRCI moderate category for algal biomass. An algal cover of <80% for rock substrate has been adopted as the default value for algal cover based on the low to moderate category for algal cover.

Appendix C: Precautionary approach for recreational waters microorganisms

For recreational waters microorganisms are used as a regulatory parameter of public health significance. The indicator organism used for microbiological water quality assessment is intestinal enterococci and is related to a risk matrix which uses sanitary inspection of potential faecal contamination sources and 95th percentile levels of enterococci/100mL. The Public Health Act 1997 Recreational Water Quality Guidelines (Tasmania 2007) for a general water body (where no sanitary risk assessment has been undertaken) has determined microbial levels for investigation and action to informing the public of the elevated public health risk. These levels are at enterococci counts in a single water sample greater than 140 enterococci/100mL and when two consecutive water samples results are greater than 280 enterococci/100mL.

A precautionary approach is however recommended by the EPA, being that microbial levels should be at 40 enterococci/100mL or less and this should be the DGV for this key indicator. Refer to the Australian Government Guidelines for Managing Risk in Recreational Water for more detail on the classification matrix for faecal pollution of recreational water and other key indicators DGVs.

ENVIRONMENT PROTECTION AUTHORITY