Environmental Protection (Water and Wetland Biodiversity) Policy 2019

# Pine River and Redcliffe Creeks Environmental Values and Water Quality Objectives

Part of Basin 142

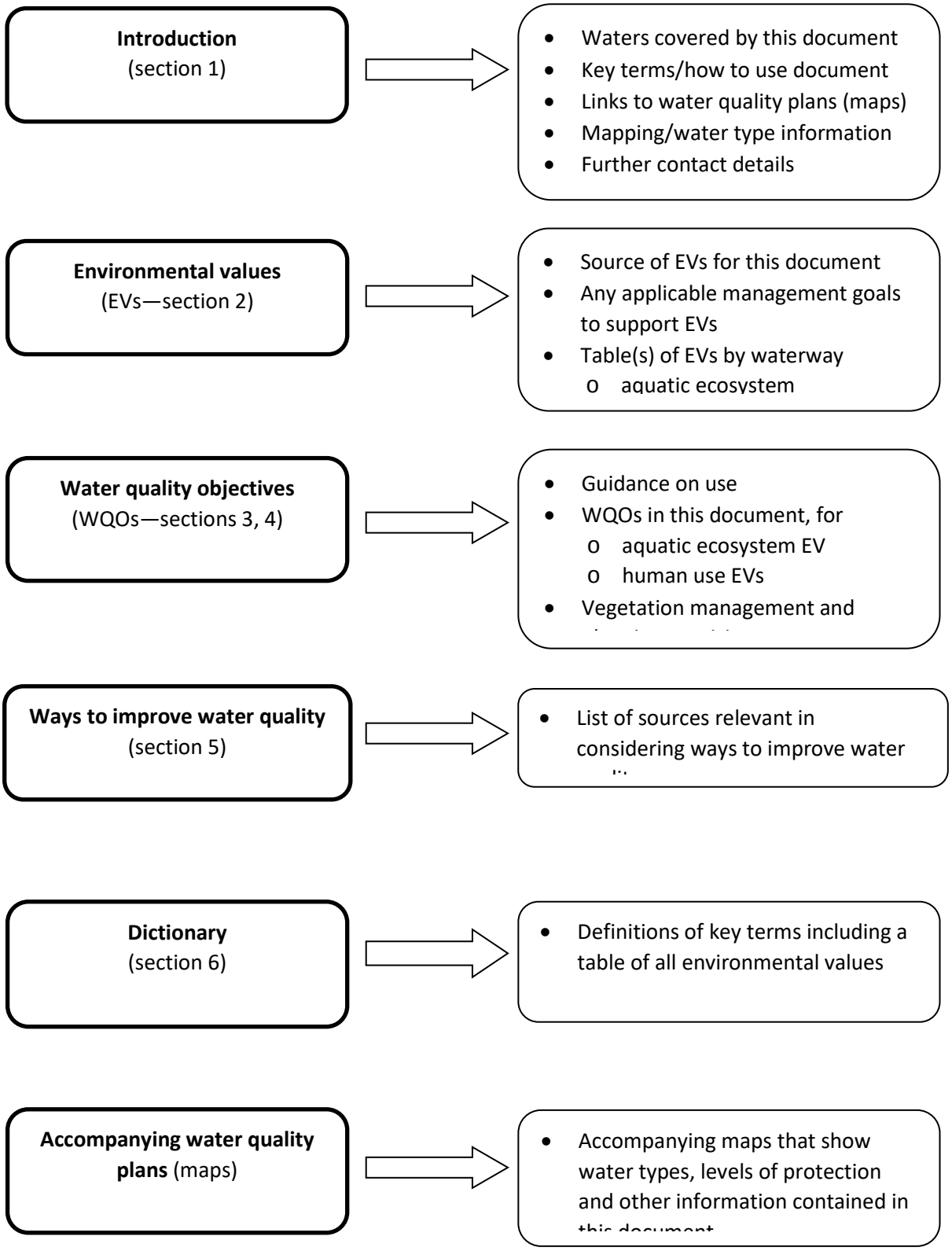
Queensland Government

Prepared by: Environmental Policy and Planning Division, Department of Environment and Science



June 2022

# Main parts of this document and what they contain



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# 1 Introduction

This document is made pursuant to the provisions of the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP [Water and Wetland Biodiversity]), which is subordinate legislation under the *Environmental Protection Act 1994*. The EPP (Water and Wetland Biodiversity) provides a framework for:

- identifying environmental values (EVs) for Queensland waters and wetlands
- identifying the management intent for waters
- identifying management goals for waters
- stating the water quality objectives (WQOs) for different water types to protect or enhance the identified EVs for waters (noting that WQOs are long-term goals for receiving waters, not individual point source emission objectives.)
- including the identified EVs, management intent and WQOs for waters under Schedule 1 of the EPP (Water and Wetland Biodiversity).

This document contains EVs and WQOs for surface fresh and estuarine waters in the Pine Rivers and Redcliffe Creeks Basin and is listed under schedule 1 of the EPP (Water and Wetland Biodiversity). For information on wetland EVs, refer to section 7 of the EPP (Water and Wetland Biodiversity).

The accompanying plan (WQ1421) identifies the EVs and management intent for the different water types in the Pine River and Redcliffe Creeks Basin (e.g. fresh, estuarine and coastal waters etc.).

## 1.1 Purpose

The purpose of this document and the accompanying plan (WQ1421) is to identify locally relevant environmental values (EVs), and water quality objectives (WQOs) for surface fresh and estuarine waters in the Pine River and Redcliffe Creeks Basin, pursuant to section 12 of the EPP (Water and Wetland Biodiversity) for inclusion in Schedule 1 of the EPP (Water and Wetland Biodiversity). EVs and WQOs are used to help set development conditions, influence local government planning schemes, and underpin report card grades for ecosystem health monitoring programs. Aquatic ecosystem water quality objectives have, where possible, been established using local data, and present a truer picture of the physico-chemical water quality of local waterways than national and state water quality guidelines. The adoption of local water quality monitoring data in deriving WQOs ensures the values the community holds for its waterways can be maintained and improved.

## 1.2 Queensland waters to which this document applies

This document applies to surface fresh and estuarine waters draining the Pine River and Redcliffe Creeks Basin (Basin 142[1]), as indicated in the accompanying plan (WQ1421).

## 1.3 Guidance on using this document

### 1.3.1 Key terms (refer to EPP (Water and Wetland Biodiversity) and dictionary for additional terms)

**ADWG** means the Australian Drinking Water Guidelines (2011, as amended), published on the National Health and Medical Research Council (NHMRC) website.

[1] Australia's River Basins 1997—Product User Guide. Published by Geoscience Australia. Canberra, ACT (3rd edition, 2004).

**ANZG** (previously ANZECC) means the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018, as amended), published on the Australian Government's Water Quality Australia website.

**Environmental values (EVs) for water** means the EVs specified in the EVs tables of this document for the corresponding water.
EVs for water are the qualities of water that make it suitable for supporting aquatic ecosystems and human water uses. The EVs need to be protected from the effects of habitat alteration, waste releases, contaminated runoff and changed flows to ensure healthy aquatic ecosystems and waterways that are safe for community use. Particular waters may have different EVs. The range of EVs and the waters to which they can potentially apply are listed below, and further details are provided in the dictionary.

### List of EVs and potentially applicable waters

| Environmental value (EV) | Potentially applicable to: | |
|---|---|---|
| | Tidal waters | Fresh (non-tidal) waters |
| **Protection of aquatic ecosystems (aquatic ecosystem EV)** | | |
| Protection or enhancement of aquatic ecosystem values, under four possible levels of ecosystem conditions:<br>• high ecological value (effectively unmodified) waters<br>• slightly disturbed waters<br>• moderately disturbed waters<br>• highly disturbed waters.<br>(Suitability for seagrass and wildlife habitat have also been specifically identified for some Queensland waters as a component of this EV). | ✓ | ✓ |
| **EVs other than aquatic ecosystem EV (called human use EVs)** | | |
| Suitability for drinking water supplies | | ✓ |
| Suitability for primary contact recreation (e.g. swimming) | ✓ | ✓ |
| Suitability for secondary contact recreation (e.g. boating) | ✓ | ✓ |
| Suitability for visual (no contact) recreation | ✓ | ✓ |
| Suitability of water for producing or taking aquatic foods (such as fish, shellfish and other plants and animals) that are safe and suitable for human consumption (suitability for oystering has also been specifically identified for some Queensland waters) | ✓ | ✓ |
| Protection of cultural and spiritual values, including traditional owner values of water | ✓ | ✓ |
| Suitability for industrial use (including mining, minerals refining/processing) | ✓ | ✓ |
| Suitability for aquaculture (e.g. red claw, barramundi) | | ✓ |
| Suitability for crop irrigation | | ✓ |
| Suitability for stock watering | | ✓ |
| Suitability for farm supply/use | | |

**Level of protection for a water (aquatic ecosystem EV)** means the level of aquatic ecosystem condition specified for waters in the aquatic ecosystem water quality objectives tables of this document that the corresponding WQOs for that water are intended to achieve (refer to management intent definition below for further information).
**Management goal** means the goal/s stated in Section 2.2 of this document to support the EVs for waters identified in the EVs tables.

**Management intent for a water (aquatic ecosystem EV)** is defined in section 15 of the EPP (Water and Wetland Biodiversity). It is the management intent for the waters that the decision to release waste water or contaminant to waters must ensure that:

- for high ecological value (HEV) waters—the measures for the indicators for all EVs of water are maintained;
- for slightly disturbed (SD) waters—the measures for the slightly modified physical or chemical indicators are progressively improved to achieve the water quality objectives for high ecological value water;
- for moderately disturbed (MD) waters:
  - if the measures for indicators of the EVs achieve the water quality objectives for the water—the measures for the indicators are maintained at levels that achieve the water quality objectives for the water, or
  - if the measures for indicators of the EVs do not achieve the water quality objectives for the water—the measures for indicators of the EVs are improved to achieve the water quality objectives for the water;
- for highly disturbed (HD) waters—the measures for the indicators of all EVs are progressively improved to achieve the water quality objectives for the water.

**QWQG** means the Queensland Water Quality Guidelines published on the Department's website.

**Water quality guidelines** (defined in the EPP (Water and Wetland Biodiversity)) are numerical concentration levels or statements for indicators that protect a stated environmental value. Under the EVs setting process contained in the EPP (Water and Wetland Biodiversity), water quality guidelines are used as an input to the development of WQOs.

**Water quality indicator (for an EV)** means a property that is able to be measured or decided in a quantitative way. Examples of water quality indicators include physical indicators (e.g. temperature), chemical indicators (e.g. nitrogen, phosphorus, metals), and biological indicators (e.g. macroinvertebrates, seagrass, fish).

**Water quality objectives (WQOs)** means the WQOs specified in tables of this document to protect the corresponding EVs for waters identified in the EVs table.

WQOs are long-term goals for water quality management. They are numerical concentration levels or narrative statements of indicators established for receiving waters to support and protect the stated EVs for those waters. Water quality objectives are not individual point source emission objectives, but the receiving water quality objectives.

WQOs are derived from scientific criteria or water quality guidelines but may be modified by consideration of economic and social impacts of protecting the EVs for the waters.

**Water type** means groupings of waters with similar characteristics, as shown in the accompanying plan. Water types can include fresh waters (lowland, upland, lakes/reservoirs), wetlands and groundwaters, estuarine waters (lower, middle and upper estuaries), intertidal wetlands, tidal canals, constructed estuaries, marinas and boat harbours, and coastal/marine waters (enclosed coastal, open coastal, midshelf, offshore). WQOs applying to different water types are outlined in this document.

### 1.3.2 Use of this document

Section 2 lists the identified EVs for protection for particular waters. The aquatic ecosystem EV is a default applying to all Queensland waters. Reference to tables in sections 3–4 provides the corresponding WQOs to protect the aquatic ecosystem EV, and human use EVs.

Where more than one EV applies to a given water, the adoption of the most stringent WQO for the identified EVs applies to each water quality indicator in order to protect all identified EVs.

This document also refers to a number of guidelines, codes and other reference sources on water quality. In particular, the QWQG provides more detailed information on water types, water quality indicators, derivation of local water quality guidelines, application during flood events, monitoring, and other matters.

## 1.4 Information about mapped attributes and boundaries

This document and the accompanying plans are available from the department's website. Schedule Outlines, EVs, water types and aquatic ecosystem management intent (level of protection) depicted in the accompanying plans are available on Queensland Globe (qldglobe) and the GIS datasets can be downloaded on Queensland Queensland Spatial Catalogue (QSpatial). For further information, email the department at epa.ev@des.qld.gov.au.

## 1.5 Water types and basis for boundaries

### 1.5.1 Water types

Water types are groupings of waters with similar characteristics. Waters in this document have been classified into different water types, as shown in the relevant tables and accompanying plans. The range of applicable water types is listed below (note that not all water types are present in all plans):

- freshwater streams and rivers, including where applicable are split into:
  - upland freshwaters—small upstream streams, moderate - fast flowing with steeper gradients than lowland freshwaters (above 150 metres altitude, or as otherwise defined)
  - lowland freshwaters—larger slow moving freshwater streams and rivers (under 150 metres altitude, or as otherwise defined)
- freshwater lakes/reservoirs
- urban lakes— a constructed lake receiving runoff from urbanised catchment (excluding water treatment ponds and stormwater treatment)
- upper estuary—waters in the upper reaches of estuaries, with limited flushing. This water type is absent from short estuaries, less than 15 kilometres (km) total estuary length
- mid estuary—waters extending the majority of the length of estuaries with a moderate amount of water movement from either freshwater inflow or tidal exchange
- lower estuary/enclosed coastal (LE/EC)—waters occurring at the downstream end of estuaries and including shallow coastal waters in adjacent enclosed bays
- marinas, boat harbours, tidal canals, and constructed estuaries
- wetlands
- open coastal (OC) and other marine waters (e.g. midshelf, offshore)—extending to the seaward limits of Queensland waters.

The water types are based on local water quality studies, mapping and definitional rules contained in the QWQG, and the ANZG. Further detail on water types is contained in these sources.

### 1.5.2 Water type boundaries

The boundaries of different water types have been mapped using a variety of attributes, including for example:

- geographic coordinates

- hydrological basin, catchment or subcatchment boundaries
- surveyed terrestrial boundaries
- altitude
- boundaries based on technical investigations
- highest/lowest astronomical tide
- tidal limiting structure (barrage/weir)
- maritime mapping conventions
- coastline.

### 1.5.3 Environmental value zones

Environmental value zones (EVZ) for waters share the same Environmental Values (EVs). These zones have previously been designated Sub-Catchment boundaries; however, EVZ boundaries do not strictly follow the definition of Sub-Catchment.

## 1.6 Matters for amendment

Amendments of the following type may be made to this schedule 1 document (and accompanying plan) for the purposes of replacement under section 13(2)(b) of the EPP (Water and Wetland Biodiversity):

- changes to EVs
- changes to management goals
- changes to WQOs
- changes to management intent (level of protection) categories
- changes to waterway or water type boundaries/descriptions
- updates to information/data sources, websites and email contact details, agency/departmental names, other institutional names, references.

# 2 Environmental values and management goals

## 2.1 Environmental values

Environmental values (EVs) for water are the qualities of water that make it suitable for supporting aquatic ecosystems and human water uses (refer key terms and dictionary to this document for further details). EVs for waters included in this document are shown in Table 1 and the accompanying plan (WQ1421).

**Table 1 Environmental values: Pine River and Redcliffe Creeks Basin surface fresh, and estuarine waters**

| PINE RIVERS AND REDCLIFFE CREEKS BASIN (Refer plan WQ1421) | Environmental values[1–5] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aquatic ecosystem | Irrigation | Farm supply/use | Stock water | Aquaculture | Human consumer [5] | Primary recreation [5] | Secondary recreation[5] | Visual recreation [5] | Drinking water [5] | Industrial use | Cultural and spiritual values |
| **Environmental Value Zone (listed alphabetically)** |  |  |  |  |  |  |  |  |  |  |  |  |
| Cedar Creek | ✓ | | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | ✓ |
| Estuary and Intertidal Wetlands of Pine River, Saltwater Creek, Fresh Water Creek, and Hays Inlet | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| Kurwongbah Creek | ✓ | | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Lake Kurwongbah | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Lower North Pine River Fresh Waters | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Lower South Pine River Fresh Waters | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| North Pine Dam | ✓ | ✓ | | | | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| North Pine River Estuary | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| Redcliffe Intertidal Wetlands | ✓ | | | | | ✓ | | ✓ | ✓ | | | ✓ |
| Redcliffe Peninsula Creeks | ✓ | ✓ | | | | ✓ | | ✓ | ✓ | | | ✓ |
| Redcliffe Canals and Harbour | ✓ | | | | | ✓ | | ✓ | ✓ | | | ✓ |

| PINE RIVERS AND REDCLIFFE CREEKS BASIN (Refer plan WQ1421) | Environmental values[1–5] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aquatic ecosystem | Irrigation | Farm supply/use | Stock water | Aquaculture | Human consumer [5] | Primary recreation [5] | Secondary recreation[5] | Visual recreation [5] | Drinking water [5] | Industrial use | Cultural and spiritual values |
| **Environmental Value Zone (listed alphabetically)** |  |  |  |  |  |  |  |  |  |  |  |  |
| Saltwater Creek and Fresh Water Creek Fresh Waters | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| South Pine River Estuary | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| Urban Lakes | ✓ | | | | | | | ✓ | ✓ | | | ✓ |
| Upper North Pine River Fresh Waters | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Upper South Pine River Fresh Waters | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | ✓ |

**Notes:**

1. ✓ means the EV is selected for protection. Blank indicates that the EV is not chosen for protection.
2. Refer to key terms and the dictionary for further explanation of EVs.
3. Refer to sections 3–4 for WQOs applying to the EVs in this table.
4. The selection of recreational and other human use EVs for waters does not mean that these waters are free of dangerous aquatic organisms, for example venomous organisms (e.g. marine stingers including box jellyfish, irukandji jellyfish), crocodiles, and sharks. Direct contact with dangerous aquatic organisms should be avoided. Refer to DES Crocodiles, council, Queensland Health, Beachsafe, marine stingers, and other information sources for further details on swimming safety and information on specific waters. Access restrictions may apply in certain locations (e.g. ports, defence, Traditional Owner lands), or at certain times of the year. Restrictions on certain activities (e.g. fishing, camping) may also apply in particular areas. Check with relevant authorities.
5. The selection of EVs for waters does not mean that these are currently free of toxicants (including bio accumulative toxicants). Information about contaminated land can be accessed by searching the Environmental Management and Contaminated Land Registers.

## 2.2 Management goals to support environmental values

### 2.2.1 Management intent for waters

Under section 15 of the EPP (Water and Wetland Biodiversity) it is the management intent for waters that the decision to release waste water or contaminants to waters must ensure the following:

- for high ecological value (HEV) waters—the measures for the indicators for all EVs of waters are maintained
- for slightly disturbed (SD) waters—the measures for the slightly modified physical or chemical indicators are progressively improved to achieve the water quality objectives for high ecological value water
- for moderately disturbed (MD) waters:
  - if the measures for indicators of the EVs achieve the water quality objectives for the water—the measures for the indicators are maintained at levels that achieve the water quality objectives for the water, or
  - if the measures for indicators of the EVs do not achieve the water quality objectives for the water—the measures for indicators are improved to achieve the water quality objectives for the water
- for highly disturbed (HD) waters—the measures for the indicators of all EVs are progressively improved to achieve the water quality objectives for the water.

Note 1 — refer to accompanying plan for locations of waters and level of protection/management intent

Note 2 — see the Environmental Protection Regulation 2019, section 35 (EP Reg). EVs, WQOs and management intent must be considered when making environment management decisions under the EP Reg.

Note 3 — see the EPP (Water and Wetland Biodiversity), section 15.

Aquatic ecosystem WQOs are provided in section 3 of this document.

### 2.2.2 Management goals for human use environmental values

Management goals for human use EVs are stated below. WQOs to support these goals are stated in section 4 of this document.

#### 2.2.2.1 Irrigation water quality

The management goal for irrigation water is that the quality of water, when used in accordance with the best irrigation and crop management practices and principles of ecologically sustainable development, does not result in crop yield loss or soil degradation (noting that water quality requirements may differ by crop type).

#### 2.2.2.2 Farm supply use

The management goal for farm supply use is that the quality of water is suitable for produce preparation and domestic uses other than drinking. (Drinking and other human uses outlined below.)

#### 2.2.2.3 Stock water quality

The management goal for stock watering is that the quality of water provided to stock does not cause deterioration in stock health or condition (noting that water quality requirements may differ by stock type).

#### 2.2.2.4 Aquaculture

The management goal for aquaculture is that the quality of water provided for aquaculture does not cause deterioration in stocked species health or condition (noting that water quality requirements may differ by species).

#### 2.2.2.5 Human consumer of aquatic foods

The management goal is that the water quality is suitable for producing or taking aquatic foods that are safe and suitable for human consumption.

#### 2.2.2.6 Recreational water quality

The management goal for recreational water quality is to achieve a low risk to human health from water quality threats posed by exposure through ingestion, inhalation or contact during recreational use of water resources.

#### 2.2.2.7 Raw water for drinking water consumption

The management goal is to:

- minimise the risk that the quality of raw water taken for treatment for human consumption results in adverse human health effects
- maintain the palatability rating of water taken for treatment for human consumption at the level of 'good' as set out in the ADWG
- minimise the risk that the quality of raw water taken for treatment for human consumption results in the odour of drinking water being offensive to consumers.

#### 2.2.2.8 Industrial use

The management goal for industrial use is that the quality of water provided to industry is, with an appropriate level of treatment, suitable for industrial use. Industries usually treat water supplies to meet their specific needs, accordingly no WQOs are specified in this document for industrial use.

#### 2.2.2.9 Cultural and spiritual values and uses of water

The management goal is that water is suitable to support identified cultural and spiritual values of waters, including those of Aboriginal people or Torres Strait Islanders. Management goals and objectives specified for aquatic ecosystems and other human water uses (including recreation, human consumption of aquatic foods, and drinking water) will assist in supporting some aspects of cultural and spiritual values of water.

# 3 Water quality objectives to protect aquatic ecosystem environmental values

Water quality objectives (WQOs) are long-term goals for water quality management. They are numerical concentration levels or narrative statements of indicators established for receiving waters to support and protect the designated EVs for those waters. Water quality objectives are not individual point source emission objectives, but the receiving water quality objectives.

Where more than one EV applies to a given water (e.g. aquatic ecosystem EV and drinking water EV), the most stringent WQO for each water quality indicator applies, which will then protect all identified EVs.

## 3.1 Aquatic ecosystem water quality objectives

This section provides physical, chemical and where available, biological water quality objectives (WQOs) to support and protect the aquatic ecosystem EV. (Human use EVs, including recreation, stock watering etc, are addressed in section 4).

The aquatic ecosystem EV is a default applying to all Queensland waters, and therefore the WQOs for aquatic ecosystems form the minimum WQOs for all waters. Where no human use EVs are identified, the WQOs identified for aquatic ecosystem protection remain applicable.

WQOs for specified indicators (including nutrients, algal, water clarity) are listed in the following table (by water type/catchment, management intent, and flow regime/season where indicated):

- Table 2: fresh waters, lakes and reservoirs, and estuarine waters

Details on management intent are included in the table and notes supporting table. Links to wetland, riparian, and State Planning Policy (state interest – water quality) mechanisms are provided in and after the table.

### 3.1.1 Comparison of test data with WQOs

The following protocols are recommended when comparing fresh, estuarine or coastal/marine water quality (at a 'test' site) with the corresponding aquatic ecosystem water quality objective (WQO). For concentration-based indicators (e.g. nutrients) and turbidity (NTU), the intent is for test site water quality value to be less than or equal to the corresponding WQO. For WQO indicators where a range is specified (e.g. pH, DO), the intent is that the test site water quality median value falls within the specified WQO range. For Secchi and silicate (typically used in estuarine, coastal and marine waters), the intent is for the test site water quality value to be greater than or equal to the stated WQO. Further detail on protocols for assessing test data against WQOs is provided in the QWQG.

For HEV and SD waters:

- For HEV and SD waters, the criterion of no change beyond natural variability is prescribed for biological indicators, physical and chemical stressors, sediments, habitat, and flow.
- Where the WQO is expressed as a $20^{th}$–$50^{th}$–$80^{th}$ percentile range of values (e.g. Total N: 65–100–125 µg/L), the $20^{th}$–$50^{th}$–$80^{th}$ percentile distributions of the test data should meet the specified range of values. The sample number is a minimum of 24 test values over the relevant period (12 months if a continuous activity or alternatively a shorter period for activities where discharge occurs for only part of the year).
- Where a single WQO value is provided, the median value of preferably five or more independent samples at a monitoring (test) site should be compared with, and should be less than or equal to, the corresponding aquatic ecosystem WQO (except where otherwise indicated).
- Detailed methods for assessing change and a statistical protocol for assessing medium to long term compliance in HEV waters are included in the Queensland Water Quality Guidelines.

For MD and HD waters:

- The median value (e.g. concentration) of preferably five or more independent samples at a monitoring (test) site should be compared with, and should be less than or equal to, the corresponding aquatic ecosystem WQO (except where otherwise indicated).
- For DO and pH, the median value of preferably five or more independent samples at a monitoring (test) site is compared with, and should fall within, the specified percentile range.
- Refer to the Queensland Water Quality Guidelines for further information.

For toxicants in water: unless otherwise stated, WQOs for toxicants are derived from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) default guideline values for the corresponding level of species protection. The ANZG recommends that the $95^{th}$ percentile of test data is compared against the default guideline value. As the proportion of test values that is required to be less than the default guideline value is high, the ANZG indicates that a single observation greater than the default guideline value is considered an exceedance.

For comparisons of toxicants in sediments, refer to ANZG.

Further information: Refer to the QWQG, the Queensland Monitoring and Sampling Manual (2018), and ANZG for more details.

**Table 2 Aquatic ecosystem water quality objectives – Upland and lowland fresh waters, lakes and reservoirs, and estuarine waters**

| Environmental Value Zone/ Water Type | Management intent /Level of protection | PINE RIVERS AND REDCLIFFE CREEKS BASIN (refer plan WQ1421) [1–5] Aquatic ecosystem water quality objectives | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Note:** WQOs for indicators are shown as a range of 20th, 50th and 80th percentiles to be maintained or achieved (e.g. 3–4–5), lower and upper limits (e.g. pH: 7.2–8.2), or as a single value for which a median of test data should be equal to or less than (e.g. 15). Refer to Section 3.1.1 for more details on how to apply WQOs. HEV – high ecological value; SD – slightly disturbed; MD – moderately disturbed. ID – insufficient data; NA – not applicable | | | | | | | | | | | |
| | | **Ammonia** (µg/L) | **Oxidised Nitrogen** (µg/L) | **Total Nitrogen** (µg/L) | **Filterable Reactive Phosphorus** (µg/L) | **Total Phosphorus** (µg/L) | **Chlorophyll-a** (µg/L) | **Dissolved Oxygen[2]** (% saturation) | **Turbidity** (NTU) | **Secchi** (m) | **Total Suspended Solids[3]** (mg/L) | **pH** | **Conductivity** (µS/cm) |
| **PINE RIVERS AND REDCLIFFE CREEKS – upland fresh waters** | | | | | | | | | | | | | |
| **All Upland** | **HEV/SD** | **Low flow** <0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 3–5–8 | 3–10–40 | 100–160–216 | 3–4–10 | 10–14–30 | 1–2–2 | 90–100–110 | 2–3–6 | NA | 2–2–3 | 6.6-6.9-7.4 | 150–170–190 |
| | | **High flow** ≥0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 3–5–8 | 3–10–40 | 114–160–216 | 2–5–16 | 10–20–35 | 1–2–2 | 90–100–110 | 3–6–10 | NA | 1–3–5 | 6.6-6.9-7.4 | 110–120–180 |
| **All Upland** | **MD** | **Low flow** <0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 10 | 10 | 220 | 6 | 15 | 2.0 | 90 – 110 | 5 | NA | 2 | 6.5 – 8.2 | 190 |
| | | **High flow** ≥0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 10 | 30 | 220 | 10 | 25 | 2.0 | 90 – 110 | 10 | NA | 5 | 6.5 – 8.2 | 180 |

| Environmental Value Zone/ Water Type | Management intent /Level of protection | PINE RIVERS AND REDCLIFFE CREEKS BASIN (refer plan WQ1421) [1–5] Aquatic ecosystem water quality objectives | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Note:** WQOs for indicators are shown as a range of 20th, 50th and 80th percentiles to be maintained or achieved (e.g. 3–4–5), lower and upper limits (e.g. pH: 7.2–8.2), or as a single value for which a median of test data should be equal to or less than (e.g. 15). Refer to Section 3.1.1 for more details on how to apply WQOs. HEV – high ecological value; SD – slightly disturbed; MD – moderately disturbed. ID – insufficient data; NA – not applicable | | | | | | | | | | | |
| | | **Ammonia** (µg/L) | **Oxidised Nitrogen** (µg/L) | **Total Nitrogen** (µg/L) | **Filterable Reactive Phosphorus** (µg/L) | **Total Phosphorus** (µg/L) | **Chlorophyll-a** (µg/L) | **Dissolved Oxygen[2]** (% saturation) | **Turbidity** (NTU) | **Secchi** (m) | **Total Suspended Solids[3]** (mg/L) | **pH** | **Conductivity** (µS/cm) |
| **PINE RIVERS AND REDCLIFFE CREEKS – lowland fresh waters** | | | | | | | | | | | | | |
| **All lowland** | **HEV/SD** | **Low flow** <0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 3–5–8 | 3–10–50 | 100–160–216 | 3–4–10 | 10–14–30 | 1–2–3 | 85–100–110 | 2–3–6 | NA | 2–2–3 | 6.6-6.9-7.4 | 150–170–190 |
| | | **High flow** ≥0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 3–5–8 | 3–10–50 | 114–160–216 | 2–5–16 | 10–20–35 | 1–2–2 | 85–100–110 | 3–6–10 | NA | 1–3–5 | 6.6-6.9-7.4 | 110–120–180 |
| **Upper North Pine River Fresh Waters; Upper South Pine River Fresh Waters; Cedar Creek** | **MD** | **Low flow** <0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 13 | 10 | 220 | 7 | 16 | 2.0 | 85 – 110 | 5 | NA | 2 | 6.5 – 8 | 290 |
| | | **High flow** ≥0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 10 | 80 | 440 | 8 | 18 | 1.5 | 85 – 110 | 5 | NA | 5 | 6.5 – 8 | 150 |
| **Lower North Pine River Fresh Waters; Lower South Pine River Fresh Waters; Saltwater Creek and Fresh Water Creek Fresh Waters; Redcliffe Peninsula Creeks** | **MD** | **Low flow** <0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 10 | 10 | 300 | 6 | 25 | 4.0 | 85 – 110 | 5 | NA | 4 | 6.5 – 8 | 390 |
| | | **High flow** ≥0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 10 | 30 | 470 | 6 | 25 | 5.7 | 85 – 110 | 5 | NA | 5 | 6.5 – 8 | 230 |

| Environmental Value Zone/ Water Type | Management intent /Level of protection | PINE RIVERS AND REDCLIFFE CREEKS BASIN (refer plan WQ1421) [1–5] Aquatic ecosystem water quality objectives | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Note:** WQOs for indicators are shown as a range of 20th, 50th and 80th percentiles to be maintained or achieved (e.g. 3–4–5), lower and upper limits (e.g. pH: 7.2–8.2), or as a single value for which a median of test data should be equal to or less than (e.g. 15). Refer to Section 3.1.1 for more details on how to apply WQOs. HEV – high ecological value; SD – slightly disturbed; MD – moderately disturbed. ID – insufficient data; NA – not applicable | | | | | | | | | | | |
| | | **Ammonia** (µg/L) | **Oxidised Nitrogen** (µg/L) | **Total Nitrogen** (µg/L) | **Filterable Reactive Phosphorus** (µg/L) | **Total Phosphorus** (µg/L) | **Chlorophyll-a** (µg/L) | **Dissolved Oxygen[2]** (% saturation) | **Turbidity** (NTU) | **Secchi** (m) | **Total Suspended Solids[3]** (mg/L) | **pH** | **Conductivity** (µS/cm) |
| **Kurwongbah Creek** | **MD** | **Low flow** <0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 10 | 10 | 300 | 10 | 30 | 5.0 | 85 – 110 | 5 | NA | 4 | 6.5 – 8 | 330 |
| | | **High flow** ≥0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 5 | 55 | 390 | 10 | 25 | 5.0 | 85 – 110 | 5 | NA | 2 | 6.5 –8 | 460 |
| **PINE RIVERS AND REDCLIFFE CREEKS – wallum waters** | | | | | | | | | | | | | |
| **All zones with Wallum water type** | **HEV/SD** | **Low flow** <0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 6–8–15 | 12–30–38 | 160–224–320 | 1–1–3 | 4–7–9 | 1–2–2 | 85–100–110 | 1–1–2 | NA | 1–2–5 | 4.6–4.8–5.7 | 80–85–120 |
| | | **High flow** ≥0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 5–16–18 | 2–6–18 | 300–360–468 | 1–2–3 | 6–10–15 | 1–2–2 | 85–100–110 | 1–2–8 | NA | 2–7–11 | 4.4–4.7–5.5 | 75–85–95 |
| **All zones with Wallum water type** | **MD** | **Low flow** <0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 15 | 40 | 320 | 3 | 9 | 5.0 | 85 – 110 | 5 | NA | 5 | 4.5 – 6.0 | 120 |
| | | **High flow** ≥0.4m³/s (cumecs) gauge 142202A | | | | | | | | | | | |
| | | 18 | 18 | 470 | 3 | 15 | 5.0 | 85 – 110 | 8 | NA | 11 | 4.5 – 6.0 | 95 |

| Environmental Value Zone/ Water Type | Management intent /Level of protection | PINE RIVERS AND REDCLIFFE CREEKS BASIN (refer plan WQ1421) [1–5] Aquatic ecosystem water quality objectives | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Note:** WQOs for indicators are shown as a range of 20th, 50th and 80th percentiles to be maintained or achieved (e.g. 3–4–5), lower and upper limits (e.g. pH: 7.2–8.2), or as a single value for which a median of test data should be equal to or less than (e.g. 15). Refer to Section 3.1.1 for more details on how to apply WQOs. HEV – high ecological value; SD – slightly disturbed; MD – moderately disturbed. ID – insufficient data; NA – not applicable | | | | | | | | | | | |
| | | **Ammonia** (µg/L) | **Oxidised Nitrogen** (µg/L) | **Total Nitrogen** (µg/L) | **Filterable Reactive Phosphorus** (µg/L) | **Total Phosphorus** (µg/L) | **Chlorophyll-a** (µg/L) | **Dissolved Oxygen[2]** (% saturation) | **Turbidity** (NTU) | **Secchi** (m) | **Total Suspended Solids[3]** (mg/L) | **pH** | **Conductivity** (µS/cm) |
| **PINE RIVERS AND REDCLIFFE CREEKS – freshwater lakes and reservoirs** | | | | | | | | | | | | | |
| **Lake Kurwongbah** | **MD** | **All Flow** WQOs apply to surface (epilimnion) waters only during periods of stratification. Where seasonal (month) ranges are provided, these are a guide only as seasonal changes and lake turn-over may occur at slightly different times each year. | | | | | | | | | | | |
| | | April-July: 17 Aug-Mar: 10 | May-Aug: 50 Sep-Apr: 10 | 540 | 5 | 20 | 4 | 75 – 110 | 3 | 1.4 | 3 | 7.1 – 7.7 | 110 - 180 |
| **North Pine Dam** | **MD** | **All Flow** WQOs apply to surface (epilimnion) waters only during periods of stratification. Where seasonal (month) ranges are provided, these are a guide only as seasonal changes and lake turn-over may occur at slightly different times each year. | | | | | | | | | | | |
| | | 10 | Mar-Aug: 60 Sep-Feb: 10 | 510 | 5 | 16 | 9 | 85 – 110 | 2 | 1.5 | 3 | 7.6 – 8.4 | 170 - 250 |
| **Urban Lakes [4]** | **MD** | **Low flow** Flow conditions of urban lakes can be determined by their surrounding catchment (These values are not to be applied during or after high flow events) | | | | | | | | | | | |
| | | NA | NA | 650 | NA | 60 | 15 | 50 – 95 | 8 | NA | NA | NA | NA |

| Environmental Value Zone/ Water Type | Management intent /Level of protection | PINE RIVERS AND REDCLIFFE CREEKS BASIN (refer plan WQ1421) [1–5] Aquatic ecosystem water quality objectives | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Note:** WQOs for indicators are shown as a range of 20th, 50th and 80th percentiles to be maintained or achieved (e.g. 3–4–5), lower and upper limits (e.g. pH: 7.2–8.2), or as a single value for which a median of test data should be equal to or less than (e.g. 15). Refer to Section 3.1.1 for more details on how to apply WQOs. HEV – high ecological value; SD – slightly disturbed; MD – moderately disturbed. ID – insufficient data; NA – not applicable | | | | | | | | | | | |
| | | **Ammonia** (µg/L) | **Oxidised Nitrogen** (µg/L) | **Total Nitrogen** (µg/L) | **Filterable Reactive Phosphorus** (µg/L) | **Total Phosphorus** (µg/L) | **Chlorophyll-a** (µg/L) | **Dissolved Oxygen[2]** (% saturation) | **Turbidity** (NTU) | **Secchi** (m) | **Total Suspended Solids[3]** (mg/L) | **pH** | **Conductivity** (µS/cm) |
| **PINE RIVERS AND REDCLIFFE CREEKS – upper estuary waters** | | | | | | | | | | | | | |
| **North Pine River Upper Estuary** | **MD** | **Low flow** Conductivity >5,000 µS/cm | | | | | | | | | | | |
| | | 11 | 5 | 450 | 5 | 30 | 4.1 | 85 – 105 | 6 | 0.5 | 9 | 7.0 – 8.4 | NA |
| | | **High flow** Conductivity ≤5,000 µS/cm | | | | | | | | | | | |
| | | 7 | 4 | 410 | 4 | 25 | 3.3 | 85 – 105 | 6 | 0.5 | 25 | 7.0 – 8.4 | NA |
| **South Pine River Upper Estuary** | **MD** | **Low flow** Conductivity >15,000 µS/cm | | | | | | | | | | | |
| | | 25 | 15 | 450 | 5 | 30 | 2.7 | 85 – 105 | 5 | 1.2 | 9 | 7.0 – 8.4 | NA |
| | | **High flow** Conductivity ≤15,000 µS/cm | | | | | | | | | | | |
| | | 15 | 55 | 540 | 16 | 50 | 2.1 | 85 – 105 | 10 | 0.9 | 25 | 7.0 – 8.4 | NA |

| Environmental Value Zone/ Water Type | Management intent /Level of protection | PINE RIVERS AND REDCLIFFE CREEKS BASIN (refer plan WQ1421) [1–5] Aquatic ecosystem water quality objectives | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Note:** WQOs for indicators are shown as a range of 20th, 50th and 80th percentiles to be maintained or achieved (e.g. 3–4–5), lower and upper limits (e.g. pH: 7.2–8.2), or as a single value for which a median of test data should be equal to or less than (e.g. 15). Refer to Section 3.1.1 for more details on how to apply WQOs. HEV – high ecological value; SD – slightly disturbed; MD – moderately disturbed. ID – insufficient data; NA – not applicable | | | | | | | | | | | |
| | | **Ammonia** (µg/L) | **Oxidised Nitrogen** (µg/L) | **Total Nitrogen** (µg/L) | **Filterable Reactive Phosphorus** (µg/L) | **Total Phosphorus** (µg/L) | **Chlorophyll-a** (µg/L) | **Dissolved Oxygen[2]** (% saturation) | **Turbidity** (NTU) | **Secchi** (m) | **Total Suspended Solids[3]** (mg/L) | **pH** | **Conductivity** (µS/cm) |
| **PINE RIVERS AND REDCLIFFE CREEKS – middle estuary waters** | | | | | | | | | | | | | |
| **North Pine River Middle Estuary** | **MD** | **Low flow** Conductivity >20,000 µS/cm | | | | | | | | | | | |
| | | 10 | 10 | 300 | 6 | 25 | 2.5 | 85 – 105 | 4 | 1.5 | 7 | 7.0 – 8.4 | NA |
| | | **High flow** Conductivity ≤20,000 µS/cm | | | | | | | | | | | |
| | | 19 | 65 | 520 | 20 | 45 | 1.9 | 85 – 105 | 8 | 1.1 | 20 | 7.0 – 8.5 | NA |
| **South Pine River Middle Estuary** | **MD** | **Low flow** Conductivity >30,000 µS/cm | | | | | | | | | | | |
| | | 10 | 8 | 300 | 6 | 25 | 3.1 | 85 – 105 | 4 | 1.4 | 7 | 7.0 – 8.4 | NA |
| | | **High flow** Conductivity ≤30,000 µS/cm | | | | | | | | | | | |
| | | 35 | 20 | 530 | 10 | 45 | 2.6 | 85 – 105 | 9 | 0.9 | 20 | 7.0 – 8.5 | NA |

| Environmental Value Zone/ Water Type | Management intent /Level of protection | **PINE RIVERS AND REDCLIFFE CREEKS BASIN (refer plan WQ1421)** [1–5]<br>**Aquatic ecosystem water quality objectives** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Note:** WQOs for indicators are shown as a range of 20th, 50th and 80th percentiles to be maintained or achieved (e.g. 3–4–5), lower and upper limits (e.g. pH: 7.2–8.2), or as a single value for which a median of test data should be equal to or less than (e.g. 15). Refer to Section 3.1.1 for more details on how to apply WQOs.<br>HEV – high ecological value; SD – slightly disturbed; MD – moderately disturbed. ID – insufficient data; NA – not applicable | | | | | | | | | | | |
| | | **Ammonia** (µg/L) | **Oxidised Nitrogen** (µg/L) | **Total Nitrogen** (µg/L) | **Filterable Reactive Phosphorus** (µg/L) | **Total Phosphorus** (µg/L) | **Chlorophyll-a** (µg/L) | **Dissolved Oxygen**[2] (% saturation) | **Turbidity** (NTU) | **Secchi** (m) | **Total Suspended Solids**[3] (mg/L) | **pH** | **Conductivity** (µS/cm) |
| **Pine River Middle Estuary** | **MD** | **Low flow**<br>Conductivity >30,000 µS/cm | | | | | | | | | | | |
| | | 6 | 5 | 260 | 6 | 25 | 1.7 | 85 – 105 | 5 | 1.5 | 7 | 7.0 – 8.4 | NA |
| | | **High flow**<br>Conductivity ≤30,000 µS/cm | | | | | | | | | | | |
| | | 20 | 30 | 450 | 19 | 40 | 1.9 | 85 – 105 | 7 | 1.1 | 20 | 7.0 – 8.4 | NA |
| **PINE RIVERS AND REDCLIFFE CREEKS – lower estuary/enclosed coastal waters** | | | | | | | | | | | | | |
| **All Lower Estuary and Enclosed Coastal Waters** | **MD** | **Low flow**<br>Conductivity >40,000 µS/cm | | | | | | | | | | | |
| | | 4 | 3 | 200 | 6 | 20 | 1.7 | 90 – 105 | 4 | 1.5 | 4 | 8 – 8.4 | NA |
| | | **High flow**<br>Conductivity ≤40,000 µS/cm | | | | | | | | | | | |
| | | 15 | 6 | 360 | 16 | 35 | 1.6 | 90 – 105 | 6 | 1.5 | 15 | 8 – 8.4 | NA |

| Environmental Value Zone/ Water Type | Management intent /Level of protection | PINE RIVERS AND REDCLIFFE CREEKS BASIN (refer plan WQ1421)[1–5] Aquatic ecosystem water quality objectives | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Note:** WQOs for indicators are shown as a range of 20th, 50th and 80th percentiles to be maintained or achieved (e.g. 3–4–5), lower and upper limits (e.g. pH: 7.2–8.2), or as a single value for which a median of test data should be equal to or less than (e.g. 15). Refer to Section 3.1.1 for more details on how to apply WQOs. HEV – high ecological value; SD – slightly disturbed; MD – moderately disturbed. ID – insufficient data; NA – not applicable | | | | | | | | | | | |
| | | **Ammonia** (µg/L) | **Oxidised Nitrogen** (µg/L) | **Total Nitrogen** (µg/L) | **Filterable Reactive Phosphorus** (µg/L) | **Total Phosphorus** (µg/L) | **Chlorophyll-a** (µg/L) | **Dissolved Oxygen[2]** (% saturation) | **Turbidity** (NTU) | **Secchi** (m) | **Total Suspended Solids[3]** (mg/L) | **pH** | **Conductivity** (µS/cm) |
| **PINE RIVERS AND REDCLIFFE CREEKS – Canals and Harbour** | | | | | | | | | | | | | |
| | | **All flow** | | | | | | | | | | | |
| **Redcliffe Canals and Harbour** | **MD** | 6 | 5 | 280 | 5 | 19 | 1.5 | 85 – 105 | 4 | 1.6 | 7 | 7.0 – 8.4 | NA |
| **Intertidal Wetlands[5]** | | | | | | | | | | | | | |
| **All Intertidal Wetlands[5]** | **HEV/SD** | Maintain existing water quality (20th, 50th and 80th percentiles) habitat, hydrological environment, biota, and vegetation communities. Insufficient data is available to establish WQOs for these waters. Refer to the QWQG for details on how to establish a minimum data set for deriving WQOs. | | | | | | | | | | | |
| **All Intertidal Wetlands[5]** | **MD** | Insufficient data is available to establish WQOs for these waters. Refer to the QWQG for details on how to establish a minimum data set for deriving WQOs. | | | | | | | | | | | |
| **SEAGRASS** | | | | | | | | | | | | | |
| **Intertidal Wetlands and Lower Estuary - Enclosed Coastal waters** | **All** | Maintain the existing seagrass depth limit for *Zostera muelleri* of -1.9m AHD (median) | | | | | | | | | | | |
| **Intertidal Wetlands and Lower Estuary - Enclosed Coastal waters** | **All** | The minimum WQOs needed to restore seagrass to areas where it has been lost are:<br>• median total suspended solids: <10 mg/L;<br>• median secchi depth: >1.7 m; and<br>• light attenuation coefficient: <0.9.<br>However, in areas where seagrass is intact, it is more important to maintain existing water quality. Therefore the WQOs are:<br>• local total suspended solids, turbidity, secchi and light attenuation is maintained; and<br>• local seagrass distribution and composition is maintained, as measured by:<br>o extent of seagrass;<br>o species diversity; and<br>o seagrass depth limit | | | | | | | | | | | |

| Environmental Value Zone/ Water Type | Management intent /Level of protection | PINE RIVERS AND REDCLIFFE CREEKS BASIN (refer plan WQ1421) [1–5]<br>Aquatic ecosystem water quality objectives | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Note:** WQOs for indicators are shown as a range of 20th, 50th and 80th percentiles to be maintained or achieved (e.g. 3–4–5), lower and upper limits (e.g. pH: 7.2–8.2), or as a single value for which a median of test data should be equal to or less than (e.g. 15). Refer to Section 3.1.1 for more details on how to apply WQOs.<br>HEV – high ecological value; SD – slightly disturbed; MD – moderately disturbed. ID – insufficient data; NA – not applicable | | | | | | | | | | | |
| | | **Ammonia** (µg/L) | **Oxidised Nitrogen** (µg/L) | **Total Nitrogen** (µg/L) | **Filterable Reactive Phosphorus** (µg/L) | **Total Phosphorus** (µg/L) | **Chlorophyll-a** (µg/L) | **Dissolved Oxygen[2]** (% saturation) | **Turbidity** (NTU) | **Secchi** (m) | **Total Suspended Solids[3]** (mg/L) | **pH** | **Conductivity** (µS/cm) |
| **TOXICANTS (INCLUDING METALS, BIOCIDES)** | | | | | | | | | | | | | |
| | **All** | Toxicants (including metals, biocides) in water:<br>• Refer to the ANZG (2018) 'toxicant default guideline values for water quality in aquatic ecosystems' as amended:<br>o For HEV/SD waters – refer to 99% species protection values.<br>o For MD waters – refer to 95% species protection values. Note: refer to 99% species protection values where indicated by ANZG (including for toxicants with bioaccumulation, toxicity effects).<br>• The following source, where guideline values post-date the specified ANZG guideline value, or where there is no ANZG value specified for a toxicant (Note: the ANZG specifies the date of guideline development for each toxicant)<br>o Biocides: King et al (2017, as amended) (vol 1 and 2) *Proposed aquatic ecosystem protection guideline values for pesticides commonly used in the Great Barrier Reef catchment area* (available from Queensland Government publications)<br>Note: For information on the application of toxicant guidelines in estuaries, refer to ANZG Guideline values for other water types<br>Toxicants in sediments: refer to ANZG 'toxicant default guideline values for sediment quality'<br>Ship-sourced pollutants (including sewage): Discharge of ship-sourced pollutants (including sewage) to be controlled in accordance with requirements of the Transport Operations (Marine Pollution) Act 1995 and Regulation 2018. (Refer to Maritime Services Queensland website for further information.)<br>Anti-fouling: Comply with *Anti-fouling and in-water cleaning guidelines* (2015, as amended) | | | | | | | | | | | |
| **TEMPERATURE** | | | | | | | | | | | | | |
| | **All** | Temperature varies daily and seasonally, is depth-dependent and highly site specific. Refer to QWQG for details on how to establish a temperature range (20th – 80th percentiles) based on local waterways not impacted by anthropogenic thermal influence. From an ecological effects perspective, daily maximum temperature and daily variation in temperature are key indicators, and seasonal variations also need to be identified. | | | | | | | | | | | |

**Units:** µg/L – micrograms per litre; µS/cm – microsiemens per centimetre; NTU – nephelometric turbidity units; m – metres; mg/L – milligrams per litre.

**Notes:**

1. Nutrients: Ammonia N comprises both un-ionised ammonia ($NH_3$) and ionised ammonium ($NH_4^+$). Oxidised N = $NO_2$ + $NO_3$. Ammonia N + Oxidised N = Dissolved inorganic N (DIN).

Except where specified for high flow conditions, nutrient WQOs do not apply during high flow events in fresh and estuarine waters. During periods of low flow and particularly in smaller creeks, build-up of organic matter derived from natural sources (e.g. leaf litter) can result in increased organic N levels (generally in the range of 400 to 800µg/L). This may lead to total N values exceeding the WQOs. If levels of inorganic N (Ammonia-N and Oxidised N) remain low, then high values of Total N, due to elevated levels of organic N, should not be seen as an exceedance of the WQOs, provided this is due to natural causes. See QWQG (section 5 and Appendix D) for more information on applying guidelines under high flow conditions.

2. Dissolved oxygen (DO): Dissolved Oxygen (DO) guidelines apply to daytime conditions. Lower values will occur at night in most waters. In estuaries, reductions should only be in the region of 10–15 per cent saturation below daytime values. In freshwaters, night-time reductions are more variable. Following significant rainfall events, reduced DO values may occur due to the influx of organic material. In estuaries post-event values as low as 40 per cent saturation may occur naturally for short periods but values well below this would indicate some anthropogenic effect. In freshwaters, post-event DO reductions are again more variable. In general, DO values consistently less than 50 per cent are likely to impact on the ongoing ability of fish to persist in a water body while short term DO values less than 30 per cent saturation are toxic to some fish species. Very high DO (supersaturation) values can be toxic to some fish as they cause gas bubble disease. DO values should not be applied to stagnant pools in intermittent streams as they naturally experience values of DO below 50 per cent saturation.
3. Total suspended solids – coastal waters: TSS (and hence turbidity and Secchi depth) levels in coastal waters are naturally highly variable depending on wind speed/wave height and in some cases on tidal cycles. The values in this table provide guidance on what the long term values of turbidity, Secchi depth or TSS should comply with. However, these values will often be naturally exceeded in the short term during windy weather or spring tides. They therefore should not be used for comparison with short term data sets. Where assessable coastal developments are proposed, proponents should carry out site specific intensive monitoring of these indicators (or equivalent light penetration indicators) and use these as a baseline for deriving local guidelines and for comparison with post development conditions.
4. WQOs for urban lakes apply to all waters when lake is fully mixed but only to surface waters (epilimnion) during stratified periods, noting that lakes should be designed such that the release of anoxic hypolimnetic waters to the surface or to downstream areas is minimised. Chlorophyll-a is the primary eutrophication indicator. No infestations of floating weeds such as *Eichhornia, Azolla, Lemna, Salvinia,* and *Pistia*.
5. Intertidal wetlands are found between high and low tide and can include a variety of environments such as intertidal seagrasses, mud flats, mangroves, salt marsh, and salt flats. Intertidal wetlands are flushed with estuarine water with an incoming tide. As water interacts with sediments, vegetation, algae, and biota, changes to water quality occur over each inundation and drying cycle. Combined with the variety of environments of intertidal wetlands, this means that water quality is site-specific and variable over the tidal cycle. Site-specific WQOs should be developed where required. Refer to the QWQG for details on how to establish a minimum water quality dataset for deriving local values.

## 3.2 Biological Water Quality Objectives

**Table 3 Aquatic ecosystem EV: Biological water quality objectives for freshwater streams with a Moderately Disturbed level of protection**

| Indicator[1] | | Percentile used | Water Type | | | Operant[2] | Units |
|---|---|---|---|---|---|---|---|
| | | | Wallum /tannin-stained freshwater | Lowland freshwater | Upland freshwater | | |
| Fish | Percent of native species expected (PONSE) | original guideline | 100 | 100 | 100 | >= | % |
| | Observed to expected species ratio (O/E) | used for all | 1 | 1 | 1 | >= | ratio (number) |
| | Percent Alien individuals | fish indices | 0 | 0 | 0 | = | % |
| Invertebrates | Richness (family) | 20th | 11 | 22 | 22 | >= | number |
| | PET taxa (taxa sensitive to human disturbance) | 20th | 3 | 4 | 5 | >= | number |
| | SIGNAL score (stream invertebrate grade number average level)<br>1 = most tolerant<br>10 = most sensitive | 20th | 4 | 4 | 4.6 | >= | number |
| Ecological Processes | Gross primary production (GPP) | 80th | 0.5 | 0.5 | 0.25 | <= | $gC/m^2/day$ |

| Indicator[1] | | Percentile used | Water Type | | | Operant[2] | Units |
|---|---|---|---|---|---|---|---|
| | | | Wallum /tannin-stained freshwater | Lowland freshwater | Upland freshwater | | |
| | Respiration (R24) | 80th | 0.35 | 0.35 | 0.15 | <= | $gC/m^2/day$ |
| | Carbon isotope ratio measure (Del $^{13}C$) | 20th | -28 | -28 | -28 | >= | delta units |
| | Chlorophyll-a | 80th | 12 | 12 | 8 | <= | mg Chl $a/m^2$ day |
| Nutrient Cycling | Algal bioassay (N+P)/C | 80th | 4 | 4 | 4 | <= | ratio (number) |
| | Nitrogen isotope ratio measure (Del $^{15}N$) | 80th | 5 | 5 | 5 | <= | delta units |

**Notes**:

1. More details on the indicators in this table are provided in Appendix E of the QWQG (2009), and the Ecosystem Health Monitoring Program (EHMP) annual technical reports (2002–03, 2003–04).
2. For each indicator the 'operant' denotes whether test-site values should be higher than or lower than the specified number to achieve compliance.

## 3.3 Vegetation management and planning provisions

This following is provided for information on vegetation, habitat and planning matters. While it is current at time of publication, readers should refer to relevant Queensland websites and legislation to ensure they are referring to current materials.

## 3.4 Riparian vegetation

The clearing of native vegetation in Queensland is regulated by the *Vegetation Management Act 1999*, the *Planning Act 2016* and associated policies and codes. This includes the regulation of clearing within a defined distance of watercourses and drainage features.

For vegetation management relating to waterways, reference should be made to:

- State Development Assessment Provisions (SDAP) State Code 16: Native vegetation clearing. State Code 16 requires clearing of native vegetation to meet performance outcomes relating to the protection of wetlands, watercourses and drainage features. State Code 16 outlines buffer areas where clearing cannot occur within a specified distance of watercourses or drainage features. If clearing within these buffers cannot be reasonably avoided, an offset may be required to counterbalance any significant residual impact to a wetland, watercourse or drainage feature. For more information on SDAP State code 16, refer to the Queensland's Planning System website.
- The relevant Accepted Development Vegetation Clearing Codes (ADVCC) under the *Vegetation Management Act 1999*. These codes allow self-assessable clearing for certain purposes in particular land tenures and regional ecosystems. It is a requirement across all codes for landholders to use best practice methods when clearing vegetation to prevent soil erosion and instability and to prevent increased sediment run-off entering a wetland, watercourse or drainage feature. The codes also contain riparian protection zones to prevent clearing within a defined distance of a wetland, a stream ordered watercourse or a drainage feature. Where a code permits clearing within these areas, there are additional requirements to rehabilitate the area or to legally secure an exchange area (for clearing of regulated regrowth vegetation) to counterbalance the impact. For more information on the ADVCCs and guidance material, refer to the Queensland Government's website on vegetation management.

Clearing of native vegetation in a watercourse may also require a riverine protection permit under the *Water Act 2000*. Further information is available at www.business.qld.gov.au.

Local Government Planning schemes under the *Planning Act 2016* may also specify riparian buffers (for example under catchment protection or waterway codes). For further information about planning schemes, refer to relevant local government websites and Queensland Government information on planning.

## 3.5 Wetlands

The Environmental Protection (Water and Wetland Biodiversity) Policy 2019 defines environmental values for wetlands.

The State Development Assessment Provisions (SDAP) guide the State Assessment and Referral Agency's assessment of development applications, via a coordinated, whole-of-government approach. The SDAP includes performance and acceptable outcomes for wetlands and water quality depending on the location and type of development. Appendix 1 of SDAP assists applicants in determining which of the state codes apply to a development application based on the relevant assessment triggers in the Planning Regulation 2017.

## 3.6 Marine protected areas

In Queensland, declared fish habitat areas (under the *Fisheries Act 1994*) protect the state's key estuarine and coastal fish habitats from development impacts to support sustainable fishing.

Works within declared fish habitat areas are either assessable development for which a development approval is required under the *Planning Act 2016,* or accepted development under the *Fisheries (General) Regulation 2019.* To be accepted development, works must comply with the relevant accepted development requirements. If all requirements are not met, then the development is assessable and a development approval must be applied for.

The state assesses building work or operational development that may have impacts on declared fish habitat areas against the State Development Assessment Provisions (SDAP) State code 12: Development in a declared fish habitat area. (For more information on SDAP State codes, refer to the Queensland's Planning System website.

Performance outcomes for all assessable development include (but are not limited to):

- development does not increase the risk of mortality, disease or injury, or compromise the health, productivity, marketability or suitability for human consumption of fisheries resources, having regard to (but not limited to)
  - biotic and abiotic conditions, such as water and sediment quality
  - substances that are toxic to plants or toxic to or cumulative within fish
- development maintains or improves water quality
- development likely to cause disturbance to potential or actual acid sulfate soil, prevents the release of contaminants.

In most cases a resource allocation authority is also required under the *Fisheries Act 1994* before assessable development can proceed. The Department of Environment and Science website contains further information on approvals, accepted development requirements and other aspects relating to declared fish habitat areas.

Marine parks (under the *Marine Parks Act 2004*) protect tidal lands and waters to conserve the marine environment while allowing for sustainable use. A marine park comprises zones that offer differing levels of management. Depending on the zone, activities can occur "as of right", with permission, or may be prohibited. For more information about declared fish habitat areas and marine parks, see the department's website.

## 3.7 Marine plants

Marine plants grow on or adjacent to tidal lands. They include tidal plants such as mangroves, seagrass, saltcouch, algae, samphire (succulent) vegetation and seasonally connected adjacent plants, such as melaleuca (paper barks) and casuarina (coastal she-oaks). Marine plants support local fish populations, fish catches and general aquatic health, and for this reason they are protected under the *Fisheries Act 1994*.

A material change of use, reconfiguring of a lot, and operational work that will remove, damage or destroy a marine plant is either assessable development for which a development approval is required under the *Planning Act 2016,* or accepted development under the *Fisheries (General) Regulation 2019.* Work types that are described as accepted development must comply with the relevant accepted development requirements in all respects. If all requirements are not met, then the development is assessable and must be applied for.

The state assesses development applications that may have impacts on marine plants using the State Development Assessment Provisions (SDAP) State code 11: Removal, destruction or damage of marine plants. (For more information on SDAP State codes, refer to the Queensland's Planning System website.

Performance outcomes for all development include (but are not limited to):

- development does not increase the risk of mortality, disease or injury, or compromise the health, productivity, marketability or suitability for human consumption of fisheries resources, having regard to (but not limited to)
  - biotic and abiotic conditions, such as water and sediment quality
  - substances that are toxic to plants or toxic to or cumulative within fish
- development likely to cause drainage or disturbance to acid sulfate soils, prevents the release of contaminants and impacts on fisheries resources and fish habitats.

A marine plant is a matter of state environmental significance under the *Environmental Offsets Act 2014* and an environmental offset may be required for any significant residual impact that is approved.

The Department of Agriculture and Fisheries website contains further information on approvals, accepted development requirements and other aspects relating to marine plants.

## 3.8 Waterways providing for fish passage

Waterway barrier works may inhibit the free movement of fish along waterways and onto floodplains, injure fish or affect fish health and habitat. Many native fish need to access a range of habitats for food, breeding and refuge and move or migrate to complete their lifecycle.

Adequate fish passage must be provided at any proposed waterway barrier. Operational work that is to construct or raise a waterway barrier is assessable development for which a development approval is required under the *Planning Act 2016,* or is accepted development under the *Fisheries (General) Regulation 2019.* Work types that are described as accepted development must comply with the relevant accepted development requirements in all respects. If all requirements are not met, then the development is assessable and must be applied for. The state assesses development applications that may have impacts to fish passage using the State Development Assessment Provisions (SDAP) State code 18: Constructing or raising waterway barrier works in fish habitats. For more information on SDAP State codes, refer to the 'Queensland's Planning System' website.

Performance outcomes for all development include (but are not limited to):

- development does not increase the risk of mortality, disease or injury, or compromise the health, productivity, marketability or suitability for human consumption of fisheries resources, having regard to (but not limited to)
  - biotic and abiotic conditions, such as water and sediment quality
  - substances that are toxic to plants or toxic to or cumulative within fish
- sufficient water exchange and flow is maintained and provided to sustain and where necessary restore, water quality and the health and condition of fisheries resources, ecological functions and fish passage
- development likely to cause drainage or disturbance to acid sulfate soils, prevents the release of contaminants and impacts on fisheries resources and fish habitats.

A waterway providing for fish passage is a matter of state environmental significance under the *Environmental Offsets Act 2014* and an environmental offset may be required for any significant residual impact that is approved.

The Department of Agriculture and Fisheries website contains further information on approvals, accepted development requirements and other aspects relating to waterway barrier works and fish passage.

## 3.9 State planning policy – (state interest – water quality)

The State Planning Policy (SPP) defines the Queensland Government's policies about matters of state interest in land use planning and development (a state interest is defined under the *Planning Act 2016*).

Water quality is a state interest. The SPP (state interest – water quality) seeks to ensure that 'the environmental values and quality of Queensland waters are protected and enhanced'. It includes provisions relating to receiving waters, acid sulfate soils and water supply buffer areas.

The provisions of the SPP are applied through their 'integration' into local government planning schemes. Planning schemes adopt measures prescribed in the SPP that ensure development is planned, designed, constructed and operated to manage stormwater and wastewater in ways that support the protection of environmental values and meet the water quality objectives identified in the Environmental Protection (Water and Wetland Biodiversity) Policy 2019.

This is achieved by compliance with the policy provisions of the SPP (state interest – water quality).

Stormwater management design objectives for the construction phase include developments using measures to manage the velocity of stormwater flows and prevent erosion, sediment, litter and other contaminates entering waterways while construction is occurring. Post construction phase stormwater management design objectives generally apply to lots over 2500m$^2$ that results in six or more dwellings or lots. The stormwater management design objectives seek to limit the amount of nutrients, including nitrogen and phosphorus, suspended sediments, litter, and other contaminants entering waterways from the operation of the development.

The SPP is supported by guidance materials which include integrating state interests in a planning scheme. These are available from the State Planning Policy website. Supplementary guidance is available from the Department of Environment and Science website on post construction phase stormwater management (phase 5b).

Department of State Development, Infrastructure, Local Government and Planning guidance for local government follows:

https://dsdmipprd.blob.core.windows.net/general/integrating-state-interests-in-planning-schemes-guidance-for-local-government.pdf

Further details on the State Planning Policy follow:

https://planning.statedevelopment.qld.gov.au/planning-framework/plan-making/state-planning/state-planning-policy

# 4 Water quality objectives for human use environmental values (EVs)

This section outlines water quality objectives (WQOs) to protect human use environmental values (EVs), which comprise those EVs (e.g. recreation, stock watering, aquaculture and crop irrigation) other than the aquatic ecosystem EV. The table in section 2 of this document outline's the EVs that have been identified for different waters. Where a human use EV has been identified, the following tables can be used to identify the WQOs to support that EV. Where more than one EV applies to a given water (for example aquatic ecosystem and recreational use), the adoption of the most stringent WQO for each water quality indicator will then protect all identified EVs. Note that human use WQOs tables in this section are provided for all potentially applicable human use EVs. As the range of human use EVs varies by water, reference to section 2 is required to identify the human use EVs stated for a particular water, from which the corresponding human use WQOs tables in this section can then be identified.

WQOs in this section are, unless otherwise specified, based on relevant national water quality guidelines including ANZG (2018, as amended) and the Australian Drinking Water Guidelines (ADWG). Where national guidelines or other codes remain the primary source for WQOs, reference to those national guidelines or codes is necessary to obtain comprehensive listings of all indicators and corresponding WQOs.

## 4.1 Human use EVs water quality objectives

The following table summarises WQOs for human use EVs. More details are provided in subsequent sections by human use EV.

**Table 4: Human use EVs water quality objectives**

| Environmental value | Water type/area | Water quality objective to protect EV (refer to specified codes and guidelines for full details) |
|---|---|---|
| Suitability for drinking water supply | All fresh waters including groundwaters | The Australian Drinking Water Guidelines (NHMRC, 2011, as amended) provides a framework for catchment management and source water protection for drinking water supplies.<br>Quality of raw water (prior to treatment) should consider the requirements of water supply operators, and their capacity to treat the water to make it safe for human consumption. Also refer to Table 5.<br>Whether water is drawn from surface catchments or underground sources, it is important that the local catchment or aquifer is understood, and that the activities that could lead to water contamination are identified and managed. In South East Queensland the water resource catchment area and the water supply buffer area identify these areas. See the *State Planning Policy 2017* and the interactive mapping system for assessment benchmarks around development in water supply buffer areas. Effective catchment management and source water protection include development of a catchment management plan, to prevent inappropriate development and to enforce relevant planning regulations.<br>Note: For water quality after treatment or at point of use refer to legislation and guidelines, including:<br>• *Queensland Public Health Act 2005* and Regulation (2018)<br>• *Water Supply (Safety and Reliability) Act 2008*, including the relevant drinking water quality management plan and, where applicable, the recycled water management plan for augmenting a drinking water supply under the Act and the published Drinking Water Quality Management Plan Guideline<br>• *Water Fluoridation Act 2008* and Regulation (2020)<br>• *Australian Drinking Water Guidelines* (ADWG, 2011, as amended).<br>• Safe Water on Rural Properties (Queensland Health, 2015) |

| Environmental value | Water type/area | Water quality objective to protect EV (refer to specified codes and guidelines for full details) |
|---|---|---|
| Protection of the human consumer for oystering | Estuarine and coastal waters | As per ANZG and Australia New Zealand Food Standards Code, Food Standards Australia New Zealand, as amended. (refer Food Standards Australia New Zealand website) |
| Protection of the human consumer | Fresh waters, estuarine and coastal waters | As per ANZG and Australia New Zealand Food Standards Code, Food Standards Australia New Zealand, as amended. |
| Protection of cultural and spiritual values | Fresh waters (including groundwaters), estuarine and coastal waters | Protect or restore indigenous and non-indigenous cultural heritage consistent with relevant policies and plans. |
| Suitability for industrial use | Fresh waters, estuarine and coastal waters | None provided. Water quality requirements for industry vary within and between industries. The ANZG do not provide guidelines to protect industries and indicate that industrial water quality requirements need to be considered on a case-by-case basis. This EV is usually protected by other values, such as the aquatic ecosystem EV. |
| Suitability for aquaculture | Fresh waters, estuarine and coastal waters | As per:<br>• Tables 6-8<br>• ANZG and Australia New Zealand Food Standards Code, Food Standards Australia New Zealand, as amended |
| Suitability for irrigation | All fresh waters including groundwaters | Pathogens and metal WQOs are provided in Tables 9 and 10 (based on ANZG). For all other indicators, such as salinity, sodicity, sodium adsorption ratio (SAR), and herbicides, refer ANZG. |
| Suitability for stock watering | All fresh waters including groundwaters | As per ANZG, including median faecal coliforms <100 organisms per 100 mL.<br>For total dissolved solids and metals, refer Tables 11 and 12, based on ANZG.<br>For other indicators, such as cyanobacteria and pathogens, see ANZG. |
| Suitability for farm supply/use | All fresh waters including groundwaters | As per ANZG 2018.<br>Also refer to Safe Water on Rural Properties (Queensland Health, 2015) |
| Suitability for primary contact recreation | Fresh waters, estuarine and coastal waters | Note: at time of publication the NHMRC guidelines for recreational water quality were under review, and updates may supersede the following. Refer to NHMRC website for latest information and updated guidelines.<br>As per NHMRC (2008 – refer NHMRC website) including:<br>• water free of physical (floating and submerged) hazards. Where permanent hazards exist (e.g. rips and sandbars), appropriate warning signs should be clearly displayed.<br>• temperature range: 16–34°C<br>• pH range: 6.5–8.5<br>• DO: >80%<br>• faecal contamination: designated recreational waters are protected against direct contamination with fresh faecal material, particularly of human or domesticated animal origin. Two principal components are required for assessing faecal contamination:<br>- assessment of evidence for the likely influence of faecal material<br>- counts of suitable faecal indicator bacteria (usually *enterococci*)<br>These two components are combined to produce an overall microbial classification of the recreational water body.<br>• The enterococci values in the Healthy Waterways (now Healthy Land and Water), Healthy Waterplay, Microbial Trigger Value Justification Paper, 2014 are adopted for management of recreational waters in SEQ.<br>• direct contact with venomous or dangerous aquatic organisms should be avoided. Recreational water bodies should be reasonably free of, or protected from, venomous |

| Environmental value | Water type/area | Water quality objective to protect EV (refer to specified codes and guidelines for full details) |
|---|---|---|
| | | organisms (e.g. box jellyfish and bluebottles)<br>• waters contaminated with chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreational purposes.<br>Also refer to Safe Water on Rural Properties (Queensland Health, 2015) |
| Suitability for primary contact recreation | Fresh waters | Note: at time of publication the NHMRC guidelines for recreational water quality were under review. Refer to NHMRC website for latest information and updated guidelines.<br>Red level action mode[1]:<br>Level 1 guideline: Recreational water bodies should not contain biovolume equivalent of ≥ 4 $mm^3/L$ biovolume equivalent for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume<br>or<br>Level 2 guideline: ≥ 10 $mm^3/L$ for total biovolume of all cyanobacterial material where known toxins are not present. Cyanobacterial scums should not be present.<br>A framework for managing the risks of cyanobacteria to recreational users of water was implemented by Seqwater based on toxin guideline values (Veal et al. 2018). See Section 3.6 and Veal et al. (2018) for detail.<br>Also refer to Safe Water on Rural Properties (Queensland Health, 2015) |
| | Estuarine, coastal waters | • cyanobacteria/algae: Recreational water bodies should not contain ≥ 10 cells/mL *Karenia brevis* and/or have *Lyngbya majuscula* and/or *Pfiesteria* present in high numbers[2]. Further details are contained in NHMRC (2008) and Table 13. |
| Suitability for secondary contact recreation | Fresh waters, estuarine and coastal waters | As per NHMRC (2008) and Healthy Waterways Healthy Waterplay Microbial Trigger values, including:<br>• intestinal enterococci: refer primary recreation above<br>• cyanobacteria/algae—refer Section 3.6, NHMRC (2008). |
| Suitability for visual recreation | Fresh waters, estuarine and coastal waters | As per NHMRC (2008), including:<br>• recreational water bodies should be aesthetically acceptable to recreational users. The water should be free from visible materials that may settle to form objectionable deposits; floating debris, oil, scum and other matter; substances producing objectionable colour, odour, taste or turbidity; and substances and conditions that produce undesirable aquatic life.<br>• cyanobacteria/algae—see, NHMRC (2008). |

**Notes:**

1. Level 1 recognises the probability of adverse health effects from ingestion of known toxins, in this case based on the toxicity of microcystins. Level 2 covers circumstances in which there are very high cell densities of cyanobacterial material, irrespective of the presence of toxicity or known toxins. Increased cyanobacterial densities increase the likelihood of non-specific adverse health outcomes, principally respiratory, irritation and allergy symptoms. (NHMRC, 2008; 8).
2. The NHMRC states that its guidelines are concerned 'only with risks that may be associated with recreational activities in or near coastal and estuarine waters. This includes exposure through dermal contact, inhalation of sea-spray aerosols and possible ingestion of water or algal scums, but does not include dietary exposure to marine algal toxins.' (NHMRC, 2008; 121).

**Sources:**

The WQOs were determined from a combination of sources, including:

- Technical review and advice from Queensland Health and Department of Regional Development, Manufacturing and Water (2020)
- Australian Drinking Water Guidelines (NHMRC, 2011 as updated 2016), available from NHMRC website
- Australia New Zealand Food Standards Code (Australian Government: Food Standards Australia New Zealand), available from Food Standards Australia New Zealand website
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018, as amended)
- Guidelines for Managing Risks in Recreational Water (NHMRC, 2008, as amended), available from NHMRC website. At time of publication the NHMRC guidelines were under review. Refer to NHMRC website for latest information and updated guidelines.
- Safe Water on Rural Properties (Queensland Health, 2015)

## 4.2 Drinking water EV water quality objectives

**Table 5 Drinking water EV: Priority water quality objectives for drinking water supply in the water supply buffer area, including groundwater, before treatment**

| Indicator | Water quality objective [1] |
|---|---|
| *Giardia* | 0 cysts/10L<br>If *Giardia* is detected in treated drinking water, the Water Supply Regulator, DRDMW must and Queensland Health should be notified immediately and an investigation of the likely source of contamination undertaken. |
| *Cryptosporidium* | 0 oocysts/10L<br>If *Cryptosporidium* is detected in treated drinking water, the Water Supply Regulator, DRDMW must and Queensland Health should be notified immediately and an investigation of the likely source of contamination undertaken. |
| *E. coli* | <50 CFU/100mL<br>Well designed treatment plants with effective treatment barriers and disinfection are designed to address faecal contamination. *E. coli* or thermotolerant coliforms should not be present in any 100 mL sample of (treated) drinking water (ADWG). <1 cfu/100ml (Public Health Regulation 2018) and upstream sewage effluent discharges need to be known (catchment management). If *E. coli* is detected in treated drinking water, the Water Supply Regulator, DRDMW must and Queensland Health should be notified immediately and an investigation of the likely source of contamination undertaken. |
| Algal toxin | <1.3 µg/L Microcystin (ADWG) |
| Total Cyanophytes Counts/Biovolumes | M.aeruginosa 6 500 cells/mL or BV 0.6 $mm^3/L$<br>R.raciborskii 15 000 cells/mL or BV 0.6 $mm^3/L$<br>N.spumigena 40 000 cells/mL or BV 9.1 $mm^3/L$<br>D.circinale 20 000 cells/mL or BV 5 $mm^3/L$ |
| Hardness | <200 mg/L as CaCO3 (aesthetic) |
| Taste and Odour | <5 ng/L combine MIB and Geosmin |
| Total Phosphorus | <0.05 mg/L |
| Total Nitrogen | <0.5 mg/L |
| Ammonia | <0.5 mg/L |
| Nitrate | <10 mg/L |
| pH | 6.5–8.5 (ADWG) |
| Specific Conductivity | <450 µS/cm |
| Dissolved Organic Carbon | <10 mg/L |
| Total Suspended Solids | <25 mg/L |
| Total dissolved solids (TDS) | <600mg/L<br>The concentration of total dissolved solids in treated drinking water should not exceed 600 mg/L (ADWG, based on taste considerations). |
| Colour | <50 Hazen Units |
| Sodium | General [2]: The concentration of sodium in reticulated drinking water supplies should not exceed 180 mg/L (ADWG, based on threshold at which taste becomes appreciable).<br>At-risk groups (medical) [2]: The concentration of sodium in water supplies for at-risk groups should not exceed 20 mg/L (ADWG). |

| Indicator | Water quality objective [1] |
|---|---|
| Sulfate | The concentration of sulfate in drinking water should not exceed 250 mg/L (ADWG 2011, based on taste/aesthetic considerations).<br>ADWG 2011 health guideline: <500mg/L |
| Aluminium | <0.1 mg/L |
| Arsenic | <0.01 mg/L |
| Iron (total) | <0.3 mg/L |
| Iron (dissolved) | <0.03 mg/L |
| Lead | <0.01 mg/L |
| Manganese (total) | <0.1 mg/L |
| Manganese (dissolved) | <0.01 mg/L |
| Dissolved oxygen | >85% saturation (ADWG) |
| Pesticides | Raw supplies: Refer to ADWG.<br>Treated drinking water: Refer to ADWG. |
| PFOS+PFHxS | <35 ng/L |
| PFOA | <280 ng/L |
| Microplastics <300 µm | 0 microplastics per litre |
| Other indicators (including physico-chemical indicators) | Refer to ADWG. |

**Note:** requirements relating to recycled water (e.g. for drinking water) are addressed under the Public Health Act 2005, Public Health Regulation (2018) and Water Supply (Safety and Reliability) Act 2008. Further information is available from the Queensland Health and Business Queensland websites.

1. **Source**: Australian Drinking Water Guidelines (NHMRC, 2011 as updated 2021). Technical review and advice from Seqwater, Queensland Health and Department of Regional Development, Manufacturing and Water (DRDMW) (2021).This table outlines WQOs for water **before treatment**, unless otherwise stated (e.g. ADWG). For water quality after treatment or at the point of use, refer to relevant legislation and guidelines, including *Public Health Act 2005* and Regulation, *Water Supply (Safety and Reliability) Act 2008 and Regulation*, including any approved drinking water management plan under the Act, *Water Fluoridation Act 2008*, the Australian Drinking Water Guidelines (ADWG, 2011 updated December 2013), and the Safe Water on Rural Properties guideline (Queensland Health, 2015).
2. The ADWG notes that 50 mg/L is a '*typical value*' in reticulated supplies. The ADWG value for sodium is 180 mg/L (based on level at which taste become appreciable) however '*sodium salts cannot be easily removed from drinking water*' and '*any steps to reduce sodium concentrations are encouraged*'. It further notes that '*medical practitioners treating people with severe hypertension or congestive heart failure should be aware if the sodium concentration in the patient's drinking water exceeds 20 mg/L*' (ADWG; sodium factsheet).

## 4.3 Aquaculture EV water quality objectives

The following tables outline WQOs for aquaculture, depending on water type and species.

**Table 6 Aquaculture EV: water quality objectives for tropical aquaculture**

| Water parameter | Recommended range | | Water parameter | Recommended range |
|---|---|---|---|---|
| | Fresh water | Marine | | General aquatic |
| **Dissolved oxygen** | >4 mg/L | >4 mg/L | **Arsenic** | <0.05 mg/L |
| **Temperature** | 21–32˚C | 24–33˚C | **Cadmium** | <0.003 mg/L |
| **pH** | 6.8–9.5 | 7–9.0 | **Calcium/Magnesium** | 10–160 mg/L |
| **Ammonia (TAN, total ammonia-nitrogen)** | <1.0 mg/L | <1.0 mg/L | **Chromium** | <0.1 mg/L |
| **Ammonia ($NH_3$, un-ionised form)** | <0.1 mg/L | <0.1 mg/L | **Copper** | <0.006 mg/L in soft water |
| **Nitrate ($NO_3$)** | 1–100 mg/L | 1–100 mg/L | **Cyanide** | <0.005 mg/L |
| **Nitrite ($NO_2$)** | <0.1 mg/L | <1.0 mg/L | **Iron** | <0.5 mg/L |
| **Salinity** | 0–5 psu | 15–35 psu | **Lead** | <0.03 mg/L |
| **Hardness** | 20–450 mg/L | ID | **Manganese** | <0.01 mg/L |
| **Alkalinity** | 20–400 mg/L | >100 mg/L | **Mercury** | <0.00005 mg/L |
| **Turbidity** | <80 NTU | ID | **Nickel** | <0.01 mg/L in soft water<br><0.04 mg/L in hard water |
| **Chlorine** | <0.003 mg/L | ID | **Tin** | <0.001 mg/L |
| **Hydrogen sulphide** | <0.002 mg/L | ID | **Zinc** | 0.03–0.06 mg/L in soft water<br>1–2 mg/L in hard water |

**Indicator:** psu – practical salinity unit, NTU - nephelometric turbidity units, ID – Insufficient data
**Note:** The table provides indicative water requirements for a range of aquaculture species (fresh and/or marine), recognising that not all listed species will occur in a given area, and that potential exists for changes in species under culture.

**Source:** Department of Primary Industries and Fisheries—Water Quality in Aquaculture—DPI Notes April 2004 (as amended) and DAF 2019-2020 technical review and advice.

**Table 7 Aquaculture EV: Water quality objectives for optimal growth of particular freshwater species**

| **WATER QUALITY OBJECTIVES** | | | | | | |
|---|---|---|---|---|---|---|
| Water parameter | Barramundi | Eel | Silver perch | Jade perch | Sleepy cod | Red-claw |
| Dissolved oxygen | 4–9 mg/L | >3 mg/L | >4 mg/L | >3 mg/L | >4.0 mg/L | >4.0 mg/L |
| Temperature | 26–32˚C | 23–28˚C | 23–28˚C | 23–28˚C | 22–31˚C | 23–31˚C |
| pH | 7.5–8.5 | 7.0–8.5 | 6.5–8.5 | 6.5–8.5 | 7.0–8.5 | 7.0–8.5 |
| Ammonia (TAN, Total ammonia–nitrogen) | ID | <1.0 mg/L | ID | ID | <1.0 mg/L | <1.0 mg/L |
| Ammonia ($NH_3$, un–ionised form) | <0.46 mg/L | <0.1 mg/L | <0.1 mg/L | <0.1 mg/L | <0.1 mg/L | <0.1 mg/L |
| Nitrate ($NO_3$) | ID | ID | <100 mg/L | ID | ID | ID |
| Nitrite ($NO_2$) | <1.5 mg/L | <1.0 mg/L | <0.1 mg/L | ID | <1.0 mg/L | <1.0 mg/L |
| Salinity (extended periods) | 0–35 psu | ID | <5 psu | <5 psu | ID | <4 psu |
| Salinity bath (short term treatment) | 0–35 psu | ID | 5–10 psu for 1 hour | ID | max. 20 psu for 1 hour | ID |
| Hardness ($CaCO_3$) | 50-100 mg/L | ID | >50 mg/L | >50 mg/L | >40 mg/L | >40 mg/L |
| Alkalinity | >50 mg/L | ID | 100–400 mg/L | 100–400mg/L | >40 mg/L | >40 mg/L |
| Chlorine | <0.04 mg/L | ID | ID | ID | <0.04 mg/L | ID |
| Hydrogen sulphide | <0.3 mg/L | ID | ID | ID | <0.3 mg/L | ID |
| Iron | <0.1 mg/L | ID | <0.5 mg/L | <0.5 mg/L | <0.1 mg/L | <0.1 mg/L |
| Spawning temperature | marine | ID | 23–28 | 23–28 | >24 for more than 3 days | ID |

**Indicator:** psu – practical salinity unit, ID – Insufficient data

**Note:** The table provides indicative water requirements for a range of aquaculture species (fresh and/or marine), recognising that not all listed species will occur in a given area, and that potential exists for changes in species under culture.

**Source:** Department of Primary Industries and Fisheries—Water Quality in Aquaculture—DPI Notes April 2004 (as amended) and DAF 2019-2020 technical review and advice.

## Table 8 Aquaculture EV: Water quality objectives for optimal growth of particular marine species

| Water parameter | Barramundi | | Black tiger prawn (*Penaeus monodon*) | |
|---|---|---|---|---|
| | **Hatchery** | **Grow out** | **Hatchery** | **Grow out** |
| **Dissolved oxygen** | saturation | >4 mg/L | >4 mg/L | >3.5 mg/L |
| **Temperature** | 28–30˚C optimum<br>25–31˚C range | 28–30˚C optimum | 28-30˚C | 26–32˚C |
| **pH** | approx. 8 | approx. 8 | 7.8-8.2 | 7.5–8.5 |
| **Ammonia (TAN, total ammonia-nitrogen)** | ID | 0.1–0.5 mg/L | ID | <3 mg/L |
| **Ammonia ($NH_3$, un-ionised form)** | <0.1 mg/L | <0.1 mg/L | <0.1 mg/L | <0.1 mg/L |
| **Nitrate ($NO_3$)** | <1.0 mg/L | <1.0 mg/L | <1.0 mg/L | <1.0 mg/L |
| **Nitrite ($NO_2$)** | <0.2 mg/L | <1.0 mg/L | <0.2 mg/L | <0.2 mg/L |
| **Salinity** | 28–31psu | 0–35psu | 30-35psu | 10–25 psu optimum |
| **Alkalinity** | ID | 105–125 mg/L $CaCO_3$ | ID | >80 mg/L |
| **Clarity** | ID | <10mg/L | ID | 30–40cm secchi disk |
| **Hydrogen sulphide** | ID | <0.3 mg/L | <0.1 mg/L | <0.1 mg/L |
| **Iron** | ID | <0.02 mg/L | <1 mg/L | <1.0 mg/L |
| **Spawning temperature** | ID | 28–32˚C | ID | 27–32˚C |

**Indicator:** psu – practical salinity unit, ID – Insufficient data

**Note:** The table provides indicative water requirements for a range of aquaculture species (fresh and/or marine), recognising that not all listed species will occur in a given area, and that potential exists for changes in species under culture.

**Source:** Department of Primary Industries and Fisheries—Water Quality in Aquaculture—DPI Notes April 2004 (as amended) and DAF 2019-2021 technical review and advice.

## 4.4 Irrigation EV water quality objectives

The following tables outline WQOs for irrigation, based on relevant national guidelines. The tables relate to water sourced from Queensland waters, rather than a potable water source or from a treated effluent source, for which a range of national and state guidance material is available. Note that requirements relating to recycled water are addressed under the *Public Health Act 2005*, Public Health Regulation (2018) and *Water Supply (Safety and Reliability) Act 2008*. Further information on recycled water is available from the Queensland Health and Business Queensland websites.

Specific guidelines for irrigation of public spaces with water sourced from Queensland waters are not available, though guidance on microbial quality and managing risks can be taken from the 'Guideline for low-exposure recycled water schemes' (Queensland Health).

Note that at time of publication of this document, national irrigation water quality guidelines are under review as part of ANZG (2018, as amended), and readers should refer to the ANZG website for the most up-to-date version.

The values in the following tables pertain to water suitability for irrigation with regard to criteria such as maintaining soil quality, plant phytotoxicity, minimisation of toxic metal update into food crops, and impact on farm infrastructure (ANZECC 2000, Section 9.2.5.1). These guideline values are not set to account for effects on aquatic ecosystems in source waters, or human health impacts of contact with the water. For these, reference should be made to relevant WQOs for aquatic ecosystem protection, and WQOs for other human use EVs elsewhere in this document. For safety of food for human consumption, refer to Food Standards Australia New Zealand.

The water quality objective values for thermotolerant coliforms in irrigation water are sourced from Section 4.2.3 of ANZECC 2000 Vol 1. As values may have been updated since time of publication, readers should refer to the ANZG 2018 website for the most up-to-date values to be applied as objectives.

**Table 9 Irrigation EV: Water quality objectives for thermotolerant (faecal) coliforms in irrigation waters used for food and non-food crops[1]**

| Intended use | Median values of thermotolerant coliforms (colony forming units—cfu)[2] |
|---|---|
| Raw human food crops in direct contact with irrigation water (e.g. via sprays, irrigation of salad vegetables) | <10 cfu/100 mL |
| Raw human food crops not in direct contact with irrigation water (edible product separated from contact with water, e.g. by peel, use of trickle irrigation); or crops sold to consumers cooked or processed | <1000 cfu/100 mL |
| Pasture and fodder for dairy animals (without withholding period) | <100 cfu/100 mL |
| Pasture and fodder for dairy animals (with withholding period of five days) | <1000 cfu/100 mL |
| Pasture and fodder (for grazing animals except pigs and dairy animals, such as cattle, sheep and goats) | <1000 cfu/100 mL |
| Silviculture, turf, cotton, etc. (restricted public access) | <10 000 cfu/100 mL |

**Notes:**

1. Adapted from ARMCANZ, ANZECC and NHMRC (2000).
2. Refer to AWQG, Volume 1, Section 4.2.3.3 for advice on testing protocols.

**Source**: AWQG, Volume 1, Section 4.2.3.3, Table 4.2.2. Refer to ANZG (2018, as amended) for updates to irrigation guidelines.

The water quality objective values for heavy metals and metalloids for soil cumulative load and irrigation water quality provided in the following table are sourced from Section 9.2.5 of ANZECC 2000 Vol 3. As values may have been updated since the time of publication, readers should refer to the ANZG 2018 website for the most up-to-date values to be applied as objectives.

**Table 10 Irrigation EV: Water quality objectives for heavy metals and metalloids in agricultural irrigation water— soil cumulative contamination loading limit (CCL), long-term trigger value (LTV) and short-term trigger value (STV)[1]**

| Element | Soil cumulative contaminant loading limit (CCL)[2] (kg/ha) | Long-term trigger value (LTV) in irrigation water (up to 100 years) (mg/L) | Short-term trigger value (STV) in irrigation water (up to 20 years) (mg/L) |
|---|---|---|---|
| Aluminium | ND[2] | 5 | 20 |
| Arsenic | 20 | 0.1 | 2.0 |
| Beryllium | ND | 0.1 | 0.5 |
| Boron | ND | 0.5 | Refer to AWQG, Vol 3, Table 9.2.18 |
| Cadmium | 2 | 0.01 | 0.05 |
| Chromium | ND | 0.1 | 1 |
| Cobalt | ND | 0.05 | 0.1 |
| Copper | 140 | 0.2 | 5 |
| Fluoride | ND | 1 | 2 |
| Iron | ND | 0.2 | 10 |
| Lead | 260 | 2 | 5 |
| Lithium | ND | 2.5 (0.075 for citrus crops) | 2.5 (0.075 for citrus crops) |
| Manganese | ND | 0.2 | 10 |
| Mercury | 2 | 0.002 | 0.002 |
| Molybdenum | ND | 0.01 | 0.05 |
| Nickel | 85 | 0.2 | 2 |
| Selenium | 10 | 0.02 | 0.05 |
| Uranium | ND | 0.01 | 0.1 |
| Vanadium | ND | 0.1 | 0.5 |
| Zinc | 300 | 2 | 5 |

**Notes:**

1. Concentrations in irrigation water should be less than the trigger values. Trigger values should only be used in conjunction with information on each individual element and the potential for off-site transport of contaminants (refer AWQG, Volume 3, Section 9.2.5).

2. ND = Not determined; insufficient background data to calculate CCL.

**Source:** AWQG, Volume 1, Section 4.2.6, Table 4.2.10. Refer to ANZG (2018, as amended) for updates to irrigation guidelines.

## 4.5 Stock watering EV water quality objectives

The following water quality objectives for livestock drinking water are sourced from ANZECC 2000 (Vol 1, Section 4.3). The following tables provide a summary of WQOs for a limited range of parameters for stock watering from the full range available in the source materials. The source material should be referred to for all relevant parameters and guideline values. Note that at time of publication of this document, national stock watering guidelines are under review as part of ANZG (2018, as amended), and readers should refer to the ANZG website for the most up-to-date values to be applied as objectives.

The water quality objective values for salinity (Table 11) and metals and metalloids (Table 12) in stock drinking water provided in the following tables are sourced from Sections 4.3.3 and 4.3.4 of ANZECC 2000 Vol 1. As values may have been updated since the time of publication, readers should refer to the ANZG 2018 website for the most up-to-date values to be applied as objectives.

**Table 11 Stock watering EV: Water quality objectives for tolerances of livestock to salinity, as total dissolved solids, in drinking water[1]**

| Livestock | Total dissolved solids (TDS) (mg/L) | | |
|---|---|---|---|
| | No adverse effects on animals expected. | Animals may have initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production | Loss of production and decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually |
| Beef cattle | 0–4000 | 4000–5000 | 5000–10 000 |
| Dairy cattle | 0–2500 | 2500–4000 | 4000–7000 |
| Sheep | 0–5000 | 5000–10 000 | 10 000–13 000[2] |
| Horses | 0–4000 | 4000–6000 | 6000–7000 |
| Pigs | 0–4000 | 4000–6000 | 6000–8000 |
| Poultry | 0–2000 | 2000–3000 | 3000–4000 |

**Notes:**

1. From ANZECC (1992), adapted to incorporate more recent information.

2. Sheep on lush green feed may tolerate up to 13 000 mg/L TDS without loss of condition or production.

**Source:** ANZECC, ARMCANZ (2000), Volume 1, Section 4.3.3.5, Table 4.3.1. Note that a review of stock watering tolerances under the ANZG (2018) may lead to revised values from those in this table. Refer to ANZG (2018, as amended) for further details.

## Table 12 Stock watering EV: Water quality objectives (low risk trigger values) for heavy metals and metalloids in livestock drinking water

| Metal or metalloid | Trigger value (low risk)[1,2] (mg/L) |
|---|---|
| Aluminium | 5 |
| Arsenic | 0.5 (up to 5[3]) |
| Beryllium | ND |
| Boron | 5 |
| Cadmium | 0.01 |
| Chromium | 1 |
| Cobalt | 1 |
| Copper | 0.4 (sheep), 1 (cattle), 5 (pigs), 5 (poultry) |
| Fluoride | 2 |
| Iron | not sufficiently toxic |
| Lead | 0.1 |
| Manganese | not sufficiently toxic |
| Mercury | 0.002 |
| Molybdenum | 0.15 |
| Nickel | 1 |
| Selenium | 0.02 |
| Uranium | 0.2 |
| Vanadium | ND |
| Zinc | 20 |

**Notes:**

1. Higher concentrations may be tolerated in some situations (further details provided in ANZECC, ARMCANZ (2000), Volume 3, Section 9.3.5).
2. ND = not determined, insufficient background data to calculate.
3. May be tolerated if not provided as a food additive and natural levels in the diet are low.

**Source:** ANZECC, ARMCANZ (2000), Volume 1, Section 4.3.4, Table 4.3.2. Note that a review of stock watering tolerances under the ANZG (2018) may lead to revised values from those in this table. Refer to ANZG (2018, as amended) for further details.

## 4.6 Recreation EV water quality objectives - cyanobacteria

When cyanobacteria are present in large numbers they can present a significant hazard, particularly to primary contact users of waters. Water quality guidelines for cyanobacteria in recreational waters are provided below.

Monitoring and action guidelines relative to cyanobacteria 'alert' levels are summarised below and are explained more fully in the Guidelines for Managing Risks in Recreational Water (NHMRC, 2008). Further details on the process to determine suitability of waters for recreation, relative to historical cyanobacterial levels and susceptibility to cyanobacterial contamination, are contained in sections 6 and 7 of the NHMRC guidelines.

Note: at time of publication the NHMRC guidelines for recreational water quality were under review, and updates may supersede the following. Refer to NHMRC website for latest information and updated guidelines.

**Table 13 Alert levels and corresponding actions for management of cyanobacteria risk in recreational waters**

| Green level surveillance mode | Amber level alert mode | Red level action mode |
|---|---|---|
| ≥ 500 to <5000 cells/mL *M. aeruginosa*<br>or<br>biovolume equivalent of >0.04 to <0.4 $mm^3/L$ for the combined total of all cyanobacteria. | ≥ 5000 to <50 000 cells/mL *M. aeruginosa*<br>or<br>biovolume equivalent of ≥ 0.4 to <4 $mm^3/L$ for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume[2]<br>or<br>≥ 0.4 to <10 $mm^3/L$ biovolume for the combined total of all cyanobacteria where known toxin producers are not present[3]. | **Level 1 guideline**[4]:<br>≥ 10 µg/L total microcystins<br>or<br>≥ 50 000 cells/mL toxic *M. aeruginosa* or biovolume equivalent of ≥ 4 $mm^3/L$ for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume.<br><br>**Level 2 guideline**[4]:<br>≥ 10 $mm^3/L$ for total biovolume of all cyanobacterial material where known toxins are not present.<br>or<br>cyanobacterial scums are consistently present[5]. |
| Recommended actions for alert levels[1]: | | |
| Regular monitoring. Weekly sampling and cell counts at representative locations in the water body where known toxigenic species are present (i.e. *Microcystis aeruginosa, Anabaena circinalis, Cylindrospermopsis raciborskii, Aphanizomenon ovalisporum, Nodularia spumigena*); or fortnightly for other types including regular visual inspection of water surface for scums. | Notify agencies as appropriate. Increase sampling frequency to twice weekly at representative locations in the water body where toxigenic species are dominant within the alert level definition (i.e. total biovolume) to establish population growth and spatial variability in the water body. Monitor weekly or fortnightly where other types are dominant. Make regular visual inspections of water surface for scums. Decide on requirement for toxicity assessment or toxin monitoring. | Continue monitoring as for (amber) alert mode. Immediately notify health authorities for advice on health risk. ('In action mode the local authority and health authorities warn the public of the existence of potential health risks; for example, through the media and the erection of signs by the local authority.' NHMRC, 2008; 114). Make toxicity assessment or toxin measurement of water if this has not already been done. Health authorities warn of risk to public health (i.e. the authorities make a health risk assessment considering toxin monitoring data, sample type and variability). |

**Notes:**

1. Recommended actions at different alert levels are based on NHMRC, 2008, Table 6.6—fresh waters.
2. The definition of 'dominant' is where the known toxin producer comprises 75 per cent or more of the total biovolume of cyanobacteria in a representative sample.
3. This applies where high cell densities or scums of 'non toxic' cyanobacteria are present i.e. where the cyanobacterial population has been tested and shown not to contain known toxins (mycrocystins, nodularian, cylindrospermopsin or saxitoxin).
4. Health risks and levels: Level 1 is developed to protect against short-term health effects of exposure to cyanobacterial toxins ingested during recreational activity, whereas the Level 2 applies to the circumstance where there is a probability of increased likelihood of non-specific adverse health outcomes,

principally respiratory, irritation and allergy symptoms, from exposure to very high cell densities of cyanobacterial material irrespective of the presence of toxicity or known toxins (NHMRC, 2008;114).

5. This refers to the situation where scums occur at the recreation site each day when conditions are calm, particularly in the morning. Note that it is not likely that scums are always present and visible when there is a high population as the cells may mix down with wind and turbulence and then reform later when conditions become stable.

**Source:** Based on NHMRC (2008) Guideline for Managing Risks in Recreational Water (tables 6.2, 6.6, 7.3).

NHMRC guidelines presented above for biovolume equivalent of toxigenic species are based on potential toxic effects of *M. aeruginosa*, with equivalent cell count/biovolume of other toxigenic species also assumed protective of risk to recreational users. Guidelines for total cyanobacteria biovolume where known toxic species are not dominant are included to protect from hazards of exposure to cyanobacteria at high levels.

Veal et al. (2018) outlines a management approach currently adopted by Seqwater for recreational cyanobacteria water quality based on toxin guideline values, rather than proxy indicators. Where a specific toxin guideline for recreational use was not available, toxin guideline values are based on conservatively scaled guidelines or health alert concentrations for drinking water (NHMRC 2011). Cyanotoxin guideline values are associated with action limits, where different levels of monitoring and action are triggered to minimise risk to recreational users. See Tables 14 and 15 below for management action triggers and toxin guideline values.

**Table 14 Cyanotoxin action limits for recreational waters (Veal et al. 2018, Table 1)**

| Toxin | Unit | Low Level | Medium Level | High Level | Extreme Level |
|---|---|---|---|---|---|
| Microcystin (leucine containing) (LR) mass toxicity equivalents | µg/L | <3 | ≥3 | ≥10 | ≥25 |
| Saxitoxin (carbamate saxitoxin group) (STX) toxicity equivalents | µg/L | <9 | ≥9 | ≥30 | ≥75 |
| Cylindrospermopsin | µg/L | <3 | ≥3 | ≥10 | ≥25 |
| Nodularin | µg/L | <4 | ≥4 | ≥13 | ≥30 |
| Anatoxin-a | µg/L | <3 | ≥3 | ≥10 | ≥25 |

**Table 15 Management actions, triggers, and de-escalation for management of cyanotoxin risk to recreational values (adapted from Veal et al. 2018[1], see publication for details)**

| | Low Level | Medium Level | High Level | Extreme Level |
|---|---|---|---|---|
| Trigger | Total cyanobacteria biovolume ≤1.0mm$^3$L$^{-1}$ and Toxins < Low Level | Toxins ≥ Medium Level | Toxins ≥ High Level | Toxins ≥ Extreme Level |
| Monitoring Frequency | Monthly | Fortnightly | Weekly | Weekly |
| Action | Maintain monthly monitoring. | Increased sampling frequency. | Recreational site closed to primary contact. Increased sampling frequency. | Advisory notice against secondary contact recreation. |
| De-escalation | - | 2 consecutive samples < Medium Level | 2 consecutive samples < High Level | 2 consecutive samples < Extreme Level |

[1] Veal, C.J., Neelamraju, C., Wolff, T., Watkinson, A., Shillito, D. and Canning, A. 2018. Managing cyanobacterial toxin risks to recreational users: a case study of inland lakes in south east Queensland. Water Science and Technology: Water Supply 18.5: 1719-1726. Low level biovolume trigger of ≤1.0mm$^3$L$^{-1}$ based on SEQwater advice, June 2022

The NHMRC (2008) also provides cyanobacteria recreational use guidelines for coastal and estuarine waters which are relevant for southeast Queensland. These guidelines outline monitoring and action requirements relative to cyanobacteria 'alert' levels and are summarised below in Table 16. Further details on the process to determine suitability of waters for recreation, relative to historical cyanobacterial levels and susceptibility to cyanobacterial contamination, are contained in sections 6 and 7 of the NHMRC guidelines.

Note: at time of publication the NHMRC guidelines for recreational water quality were under review, and updates may supersede the following. Refer to NHMRC website for latest information and updated guidelines.

## Table 16 Coastal and estuarine recreational waters: alert levels and corresponding actions for management of cyanobacteria risks

| Green level surveillance mode[1] | Amber level alert mode[1] | Red level action mode[1] |
|---|---|---|
| **Coastal and estuarine waters** | | |
| *Karenia brevis* | | |
| ≤ 1 cell/mL | > 1 – < 10 cells/mL | ≥ 10 cells/mL |
| *Lyngbya majuscula, Pfiesteria* spp. | | |
| History but no current presence of organism | Present in low numbers | Present in high numbers. (For *Lyngbya majuscula* this involves the relatively widespread visible presence of dislodged algal filaments in the water and washed up onto the beach) |
| *Nodularia spumigena*: See NHMRC, Chapter 6 (Cyanobacteria and algae in fresh water) for details. | | |

**Notes:**

1. Recommended actions at different alert levels are outlined below (based on NHMRC, 2008, Table 6.6—fresh waters. Similar actions are outlined for coastal/estuarine waters in NHMRC Table 7.6):
   a. **Green**: Regular monitoring. Weekly sampling and cell counts at representative locations in the water body where known toxigenic species are present (i.e. *Microcystis aeruginosa, Dolichospermum circinalis, Raphidiopsis raciborskii, Aphanizomenon ovalisporum, Nodularia spumigena*); or fortnightly for other types including regular visual inspection of water surface for scums.
   b. **Amber**: Notify agencies as appropriate. Increase sampling frequency to twice weekly at representative locations in the water body where toxigenic species (above) are dominant within the alert level definition (i.e. total biovolume) to establish population growth and spatial variability in the water body. Monitor weekly or fortnightly where other types are dominant. Make regular visual inspections of water surface for scums. Decide on requirement for toxicity assessment or toxin monitoring.
   c. **Red**: Continue monitoring as for (amber) alert mode. Immediately notify health authorities for advice on health risk. ('In action mode the local authority and health authorities warn the public of the existence of potential health risks; for example, through the media and the erection of signs by the local authority.' NHMRC, 2008; 114). Make toxicity assessment or toxin measurement of water if this has not already been done. Health authorities warn of risk to public health (i.e. the authorities make a health risk assessment considering toxin monitoring data, sample type and variability).
2. The definition of 'dominant' is where the known toxin producer comprises 75 per cent or more of the total biovolume of cyanobacteria in a representative sample.
3. This applies where high cell densities or scums of 'non toxic' cyanobacteria are present i.e. where the cyanobacterial population has been tested and shown not to contain known toxins (mycrocystins, nodularian, cylindrospermopsin or saxitoxin).
4. Health risks and levels: Level 1 is developed to protect against short-term health effects of exposure to cyanobacterial toxins ingested during recreational activity, whereas the Level 2 applies to the circumstance where there is a probability of increased likelihood of non-specific adverse health outcomes, principally respiratory, irritation and allergy symptoms, from exposure to very high cell densities of cyanobacterial material irrespective of the presence of toxicity or known toxins (NHMRC, 2008;114).
5. This refers to the situation where scums occur at the recreation site each day when conditions are calm, particularly in the morning. Note that it is not likely that scums are always present and visible when there is a high population as the cells may mix down with wind and turbulence and then reform later when conditions become stable.

**Source:** Based on NHMRC (2008) Guideline for Managing Risks in Recreational Water (tables 6.2, 6.6, 7.3).

**References**

Veal, C.J., Neelamraju, C., Wolff, T., Watkinson, A., Shillito, D. and Canning, A. 2018. Managing cyanobacterial toxin risks to recreational users: a case study of inland lakes in south east Queensland. Water Science and Technology: Water Supply 18.5: 1719-1726

## 4.7 Recreation EV water quality objectives – microbial trigger values

Microbial trigger values were developed by Healthy Waterways in 2014 (now Healthy Land and Water) under the Healthy Waterplay program. These trigger values are based on the categories of the NHMRC Guidelines for Managing Risk in Recreational Water (2008), and acceptable levels of risk for recreational waters.

When managing risks in recreational waters, the NHMRC Guidelines suggest an appropriate management approach is to classify sites based on identified pollution sources and real time predictors of contamination, which include microbial analyses. The NHMRC Guidelines provide a framework for determining a Recreational Waterway Suitability Grade of recreational water by a combination of sanitary inspection and microbial water quality assessment. The NHMRC Guidelines focus on the long-term categorisation and management of recreational waters and do not provide guidance on assessing a site at a particular point in time based on single microbial sample results, nor on short-term management actions in response to single high result microbial samples. As routine microbial monitoring, site classification, or other investigations often involve collection of a single sample per site, microbial trigger values are needed to determine when such individual results warrant acute management response actions in order to reduce immediate health risk from recreational waterway use.

Microbial trigger values were chosen to indicate the need for further investigation into causes of potentially harmful levels of pathogens at a reasonable level of public health concern; and to prompt additional public health risk mitigation, if necessary. The trigger values (outlined in the section below) are based on rationale derived from the categories set out in the Australian Government's National Health and Medical Research Council Guidelines for Managing Risk in Recreational Water, 2008. The trigger values presented herein are recommended for fresh, estuarine, and marine waters in southeast Queensland.

### 4.7.1 Microbial trigger values for fresh, estuarine, and coastal waters

For both primary and secondary contact use of recreational waterways, respective one-off (single sample) microbial trigger values are recommended. These trigger values indicate when microbial indicator bacteria concentrations are sufficiently elevated to warrant either further investigation or action to reduce the risk of potential illness as a result of recreational use of a waterway.

Warning Trigger

The first one-off (single sample) value, known as the warning trigger, triggers intensive daily resampling and investigation within 24 h of receiving results:

- For primary contact this trigger value is equal to or greater than 200 enterococci per 100 mL
- For secondary contact this trigger value is equal to or greater than 1000 enterococci per 100 mL

Action Trigger

The second one-off (single sample) value, known as the action trigger, triggers immediate temporary closure of the recreational water area:

- For primary contact this trigger is equal to or greater than 500 enterococci per 100 mL.

Additional Considerations:

Primary Contact: If the response to the primary contact warning trigger results in three consecutive days where the counts are between 201-500 enterococci per 100 mL then the response should be elevated to an action trigger response and the site should be closed to primary contact recreation. Sites should remain closed to primary contact recreation until sampling results return to less than 200 enterococci per 100 mL for three consecutive samples. In the circumstance where the responsible agent has a thorough understanding of the

recreational site, including understanding the catchment hydrology coupled with adequate monitoring data, and hence can justify reopening after two consecutive samples then this is deemed appropriate management.

Secondary Contact: If the response to the secondary contact warning trigger results in counts remaining equal to or greater than 1000 enterococci per 100 mL then the responsible agent should complete the secondary contact risk assessment matrix (provided in Appendix 2) to assess the risk to the recreational user and determine if a temporary site closure is necessary.

# 5 Ways to improve water quality

The following documents are relevant in considering ways to improve water quality in the South East Queensland region. The document list below is additional to the plans, guidelines and other sources referred to in previous sections, and is provided for information only.

**Local and regional planning**

- Council planning schemes and supporting codes, policies, available from council websites
- Resilient Rivers Initiative: SEQ Catchment Action Plans
- South East Queensland Regional Plan 2017 (ShapingSEQ)
- South East Queensland Natural Resource Management Plan 2009-2031
- Development guidelines: Water quality management in drinking water catchments (Seqwater)

**State plans, policies, guidelines, agreements etc**

- State Planning Policy (state interest – water quality)
- Queensland Coastal Management Plan
- Queensland Water Plans under the *Water Act 2000*

**Water quality guidelines**

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG)
- Queensland Water Quality Guidelines (QWQG)
- Queensland Monitoring and Sampling Manual

**Other supporting technical information**

- Information on PFAS in Queensland, including access to PFAS national environmental management plan
- Salinity Management Handbook – available on the Queensland Government Publications website
    - Chapter 10 – Waters
    - Chapter 11 – Water Quality
- Soil conservation guidelines for Queensland – available on the Queensland Government Publications website
    - Chapter 10 – Land management on flood plains
    - Chapter 11 – Stream stability
    - Chapter 13 – Gully Erosion
- Department of Environment and Science, Queensland (2021) Treatment systems, Wetland*Info* website, accessed 18 June 2022.
- Riparian Design Guidelines to Inform the Ecological Repair of Urban Waterways (2017), Beesley LS, Middleton J, Gwinn DC, Pettit N, Quinton B and Davies PM, Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.
- Guidelines for Riparian Filter Strips for Queensland Irrigators, CSIRO Land and Water, September 1999
- Fish habitat guidelines available from the DAF website, including Fisheries guidelines for conducting an inventory of instream structures in coastal Queensland, 2010 (and other Fisheries Queensland fish habitat guidelines (FHG 001 – FHG 006) referred to within).
- Healthy Waterways Incorporated – Water by Design: resources and information available on the Water by Design website

# 6 Dictionary

**AMTD** means the adopted middle thread distance which is the distance in kilometres, measured along the middle of a watercourse, that a specific point in the watercourse is from the watercourse's mouth or junction with the main watercourse (definition based on Water Regulation 2002).

**ANZECC** means the Australian and New Zealand Environment and Conservation Council.

**ANZECC Guidelines** mean the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (recently updated to become ANZG, 2018), prepared by the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

**Aquatic ecosystem** (defined in the ANZG) any watery environment from small to large, from pond to ocean, in which plants and animals interact with the chemical and physical features of the environment.

**Aquatic ecosystem** (defined in the EPP (Water and Wetland Biodiversity)) means a community of organisms living within or adjacent to water, including riparian or foreshore areas.

**Basin** means the basin name and number provided by Geoscience Australia, Canberra (3rd edition, 2004).

**Biological Integrity** (defined in the EPP (Water and Wetland Biodiversity)) for water or a wetland, means the ability of the water or wetland to support and maintain a balanced, integrative, adaptive community of organisms having a species composition, diversity and functional organisation comparable to that of the natural habitat of the locality in which the water or wetland is situated.

**Catchment** means the total area draining into a river, creek, reservoir or other body of water. The limits of a given catchment are the heights of land (such as hills or mountains) separating it from neighbouring catchments. Catchments can be made up of smaller sub-catchments.

**Ecological integrity (health)** (defined in the ANZG) means the 'health' or 'condition' of an ecosystem. The ability of an ecosystem to support and maintain key ecological processes and organisms so that their species compositions, diversity and functional organisations are as comparable as possible to those occurring in natural habitats within a region.

**Environmental value (EV)** means:

(a) a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or

(b) another quality of the environment identified and declared to be an environmental value under an Environmental Protection Policy or Regulation (e.g. water suitable for swimming in or drinking).

The EVs for water that can be identified for protection are outlined in the accompanying table.

**Queensland waters** (as defined in *Acts Interpretation Act 1954*): means all waters that are a) within the limits of the state; or b) coastal waters of the state.

**Sub-basin** means part of a basin.

**Sub-catchment** means part of a catchment.

**Toxicant** (defined in the ANZG): means a substance capable of producing an adverse response (effect) in a biological system, which may seriously injure structure or function or produce death at sufficiently high concentration.

## Table 17 Environmental values that can be identified for protection

| Environmental values and definitions | ICON (as shown on plans) |
|---|---|
| **Aquatic ecosystem**<br>'A community of organisms living within or adjacent to water, including riparian or foreshore area.' (EPP (Water and Wetland Biodiversity), schedule 2 - Dictionary)<br>The intrinsic value of aquatic ecosystems, habitat and wildlife in waterways and riparian areas, for example, biodiversity, ecological interactions, plants, animals, key species (such as turtles, platypus, seagrass and dugongs) and their habitat, food and drinking water.<br>Waterways include perennial and intermittent surface waters, groundwaters, tidal and non-tidal waters, lakes, storages, reservoirs, dams, wetlands, swamps, marshes, lagoons, canals, natural and artificial channels and the bed and banks of waterways.<br>(This EV incorporates the 'wildlife habitat' EV used in the South East Queensland Regional Water Quality Management Strategy). See below for more details on aquatic ecosystems, based on the EPP (Water and Wetland Biodiversity). |  |
| **High ecological/conservation value waters**<br>'Waters in which the biological integrity of the water is effectively unmodified or highly valued.' (EPP (Water and Wetland Biodiversity), schedule 2). | None |
| **Slightly disturbed waters**<br>'Waters that have the biological integrity of high ecological value waters with slightly modified physical or chemical indicators but effectively unmodified biological indicators.' (EPP (Water and Wetland Biodiversity), schedule 2). | None |
| **Moderately disturbed waters**<br>'Waters in which the biological integrity of the water is adversely affected by human activity to a relatively small but measurable degree.' (EPP (Water and Wetland Biodiversity), schedule 2). | None |
| **Highly disturbed waters**<br>'Waters that are significantly degraded by human activity and have lower ecological value than high ecological value waters or slightly or moderately disturbed waters.' (EPP (Water and Wetland Biodiversity), schedule 2). | None |

| Environmental values and definitions | ICON (as shown on plans) |
|---|---|
| **Irrigation**<br>Suitability of water supply for irrigation, for example, irrigation of crops, pastures, parks, gardens and recreational areas. |  |
| **Farm water supply/use**<br>Suitability of domestic farm water supply, other than drinking water. For example, water used for laundry and produce preparation. |  |
| **Stock watering**<br>Suitability of water supply for production of healthy livestock. |  |
| **Aquaculture**<br>Health of aquaculture species and humans consuming aquatic foods (such as fish, molluscs and crustaceans) from commercial ventures. |  |
| **Human consumers of aquatic foods**<br>The suitability of the water for producing aquatic foods (fish, shellfish, other animals, plants) that are safe and suitable for human consumption; and having aquatic foods that are safe and suitable for human consumption taken from it. |  |
| **Primary recreation**<br>Means a use that involves the following types of contact with the water—full body contact, frequent immersion by the face and trunk, frequent contact with spray by the face where it is likely some water will be swallowed or inhaled, or come into contact with ears, nasal passages, mucous membranes or cuts in the skin. Examples–diving, swimming, surfing (EPP (Water and Wetland Biodiversity), section 6). |  |
| **Secondary recreation**<br>Means a use that involves the following types of contact with the water—contact in which only the limbs are regularly wet, and other contact, including the swallowing of water, is unusual (examples—boating, fishing, wading) or occasional inadvertent immersion resulting from slipping or being swept into the water by a wave. (EPP (Water and Wetland Biodiversity), section 6). |  |
| **Visual recreation**<br>Means a use that does not ordinarily involve any contact with the water—for example angling from the shore, sunbathing near water (EPP (Water and Wetland Biodiversity), section 6). |  |

| Environmental values and definitions | ICON (as shown on plans) |
|---|---|
| **Drinking water supply**<br>Suitability of the water for supply as drinking water having regard to the level of treatment of the water. |  |
| **Industrial use**<br>Suitability of water supply for industrial purposes, for example, food, beverage, paper, petroleum and power industries, mining and minerals refining/processing. Industries usually treat water supplies to meet their needs. |  |
| **Cultural and spiritual values**<br>Means scientific, social or other significance to the present generation or past or future generations, including Aboriginal people or Torres Strait Islanders (EPP (Water and Wetland Biodiversity)), section 6), for example:<br>• custodial, spiritual, cultural and traditional heritage, hunting, gathering and ritual responsibilities<br>• symbols, landmarks and icons (such as waterways, turtles and frogs)<br>• lifestyles (such as agriculture and fishing). |  |