

Environmental Protection (Water) Policy 2009

**Styx River, Shoalwater Creek and
Water Park Creek Basins
Environmental Values and Water Quality Objectives**

Basins 127, 128 and 129, including all waters of the Styx River, Shoalwater Creek and Water Park basins and adjacent coastal waters

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

© State of Queensland, 2014

The Queensland Government supports and encourages the dissemination and exchange of its information. The copyright in this publication is licensed under a Creative Commons Attribution 3.0 Australia (CC BY) licence.



Under this licence you are free, without having to seek our permission, to use this publication in accordance with the licence terms.

You must keep intact the copyright notice and attribute the State of Queensland as the source of the publication.

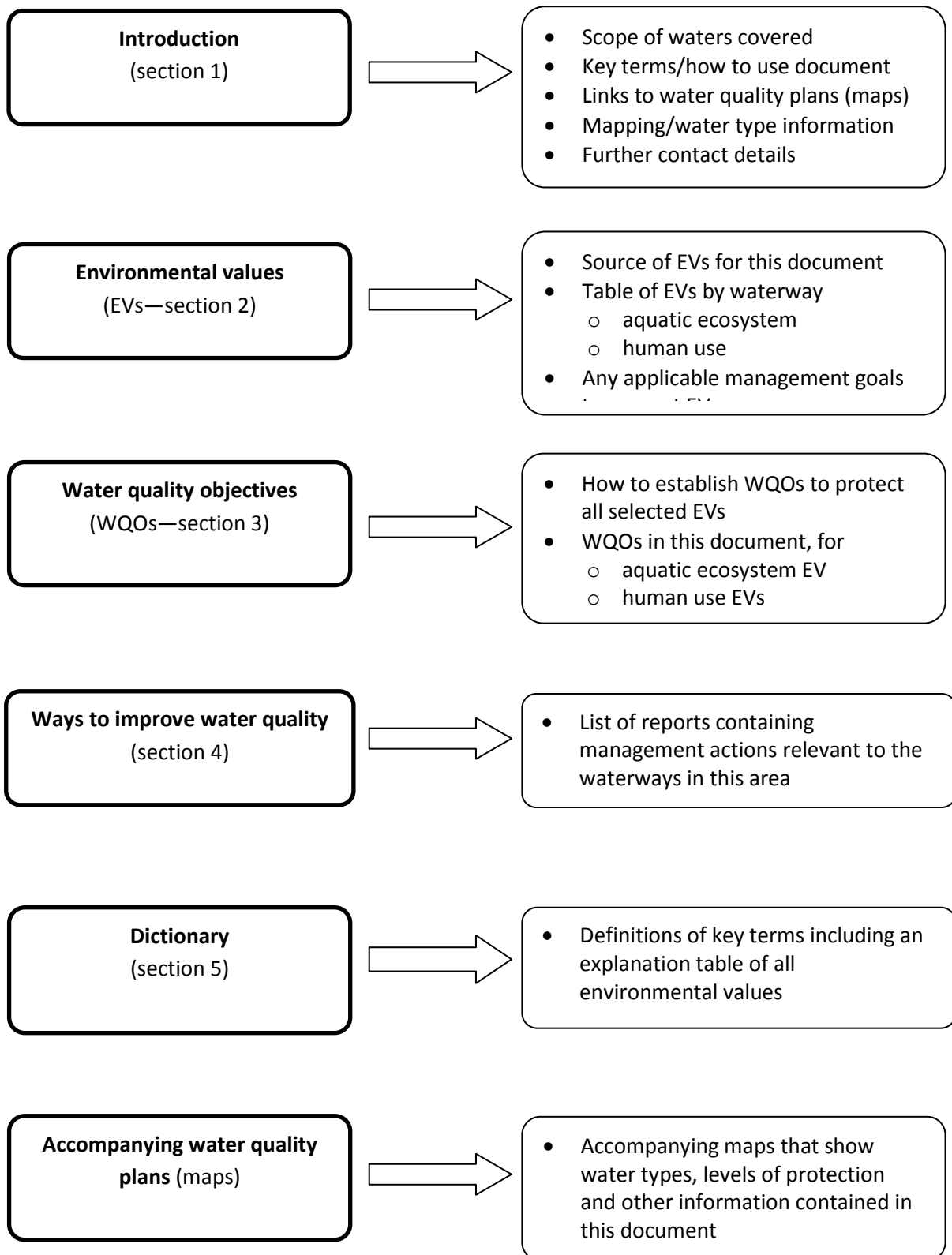
For more information on this licence, visit <http://creativecommons.org/licenses/by/3.0/au/deed.en>

If you need to access this document in a language other than English, please call the Translating and Interpreting Service (TIS National) on 131 450 and ask them to telephone Library Services on +61 7 3170 5470.

This publication can be made available in an alternative format (e.g. large print or audiotape) on request for people with vision impairment; phone +61 7 3170 5470 or email library@ehp.qld.gov.au.

November 2014

Main parts of this document and what they contain



Contents

Main parts of this document and what they contain	i
List of tables	ii
1 Introduction	1
1.1 Purpose	1
1.2 Waters to which this document applies	1
1.3 Guidance on using this document.....	3
1.4 Information about mapped areas and boundaries	5
1.5 Water types and basis for boundaries	6
1.6 Matters for amendment.....	7
2 Environmental values.....	9
2.1 Environmental values	9
2.2 Management goals to support environmental values	9
3 Water quality objectives to protect environmental values	22
3.1 Water quality objectives to protect aquatic ecosystems	22
3.2 Water quality objectives for human use environmental values	52
4 Ways to improve water quality	65
5 Dictionary	66

List of tables

Table 1A Environmental values for Styx River Basin and adjacent coastal waters	12
Table 1B Environmental values for Shoalwater Creek Basin and adjacent coastal waters	15
Table 1C Environmental values for Water Park Creek Basin and adjacent coastal waters	18
Table 2A Styx River Basin and adjacent coastal waters: Water quality objectives to protect aquatic ecosystem environmental value under baseflow conditions	25
Table 2B Shoalwater Creek Basin and adjacent coastal waters: Water quality objectives to protect aquatic ecosystem environmental value under baseflow conditions	31
Table 2C Water Park Creek Basin and adjacent coastal waters: Water quality objectives to protect aquatic ecosystem environmental value under baseflow conditions	39
Table 3 Water quality objectives to protect human use environmental values	52

Table 4 Drinking water EV: Priority water quality objectives for drinking water supply in the vicinity of off-takes, including groundwater, before treatment	55
Table 5 Aquaculture EV: Water quality objectives for tropical aquaculture	56
Table 6 Aquaculture EV: Water quality objectives for optimal growth of particular species in fresh water	57
Table 7 Aquaculture EV: Water quality objectives for optimal growth of particular marine species	58
Table 8 Irrigation EV: Water quality objectives for thermotolerant (faecal) coliforms in irrigation waters used for food and non-food crops ¹	59
Table 9 Irrigation EV: Water quality objectives for heavy metals and metalloids in agricultural irrigation water ¹ — long-term trigger value (LTV), short-term trigger value (STV) and soil cumulative contamination loading limit (CCL)	60
Table 10 Stock watering EV: Water quality objectives for tolerances of livestock to total dissolved solids (salinity) in drinking water ¹	61
Table 11 Stock watering EV: Water quality objectives (low risk trigger values) for heavy metals and metalloids in livestock drinking water	62
Table 12 Recreational waters: Alert levels and corresponding actions for management of cyanobacteria	63
Table 13 Suite of environmental values that can be chosen for protection	68
Table 14 Capricorn-Curtis Coast region surface and groundwater ions: water quality objectives (aquatic ecosystem) according to water chemistry zone and depth	72

1 Introduction

This document is made pursuant to the provisions of the Environmental Protection (Water) Policy 2009 (EPP (Water)), which is subordinate legislation under the *Environmental Protection Act 1994*. The EPP (Water) provides a framework for:

- identifying environmental values (EVs) for Queensland waters, and deciding the water quality objectives (WQOs) to protect or enhance those EVs (WQOs are long-term goals for receiving waters, not individual point source emission objectives)
- including the identified EVs and WQOs under Schedule 1 of the EPP (Water).

This document contains EVs and WQOs for waters in the Styx River, Shoalwater Creek and Water Park Creek Basins and adjacent coastal waters, and is listed under schedule 1 of the EPP (Water).

1.1 Purpose

The purpose of this document is to identify locally relevant environmental values and water quality objectives for the region, based on local historical data and in close consultation with the local community. These water quality objectives are used to help set development conditions, influence local government planning schemes and underpin report card grades for ecosystem health monitoring programs like the Gladstone Healthy Harbour Partnership and other similar programs. These water quality objectives have been refined from national and state water quality guidelines and present a truer picture of the values and water quality of local waterways. This ensures the values the community holds for its waterways can be maintained and improved into the future, without imposing unrealistic standards from national guidelines that may be inappropriate for local conditions.

1.2 Waters to which this document applies

This document applies to fresh and estuarine surface waters and groundwaters draining the basins of the Styx River, Shoalwater Creek and Water Park Creek basins (basins 127, 128 and 129¹), and coastal waters as indicated in the accompanying plans (WQ1271—surface waters, WQ1272—coastal waters, WQ1273—groundwaters)².

Waters covered by this document include:

- all Styx River Basin fresh and estuarine waters, including Styx River, Waverley and St Lawrence creeks
- all Shoalwater Creek Basin fresh and estuarine waters, including Shoalwater, Herbert and Walladah creeks
- all Water Park Creek Basin fresh and estuarine waters, including Waterpark and Coorooman creeks
- wetlands, lakes and reservoirs
- groundwaters

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

² This document and the accompanying plans are available from the department's website at www.ehp.qld.gov.au. The boundaries in the accompanying plans WQ1271, WQ1272 and WQ1273 are indicative only. EVs, water types and aquatic ecosystem management intent (level of protection) depicted in the accompanying plans are stored in electronic form as part of the Central Queensland Environmental Values Schedule 1 Geodatabase November 2014, and held at the department's offices at 400 George Street Brisbane. Geodatabase regions are based on the regions established in the Queensland Water Quality Guidelines. Spatial (GIS) datasets can be downloaded free of charge from the Queensland Spatial Catalogue (QSpatial) at <http://qldspatial.information.qld.gov.au/catalogue/custom/index.page>. For further information, email the department at epa.ev@ehp.qld.gov.au.

- enclosed coastal, open coastal and other marine waters, including waters of Broadsound, Shoalwater, Corio and Keppel bays.

The geographical extent of waters addressed by this document is shown in the accompanying plans and is broadly:

- north to the boundary of the Styx River Basin with the Plane Creek Basin
- west and south to the boundary with the Fitzroy River Basin
- east to the limit of Queensland Coastal Waters.

1.3 Guidance on using this document

1.3.1 Key terms (refer to dictionary for additional terms)

ADWG means the Australian Drinking Water Guidelines (2011, updated December 2013), prepared by the National Health and Medical Research Council (NHMRC) in collaboration with the Natural Resource Management Ministerial Council (NRMMC)³.

AWQG means the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (October 2000), 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)⁴.

Environmental values (EVs) for water means the EVs specified in Table 1 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. These 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 they can potentially apply to are listed below, and further details are provided in the dictionary (refer section 5).

List of EVs and applicable waters

Environmental value (EV)	Potentially applicable to:	
	Tidal waters	Fresh (non-tidal) waters
<p>Protection of aquatic ecosystems (aquatic ecosystem EV)</p> <p>Protection or enhancement of aquatic ecosystem values, under four possible levels of ecosystem conditions:</p> <ul style="list-style-type: none"> • high ecological value (effectively unmodified) waters • slightly disturbed waters • moderately disturbed waters • highly disturbed waters. <p>(Suitability for seagrass and wildlife habitat have also been specifically identified for some Queensland waters as a component of this EV).</p>	✓	✓
<p>EVs other than aquatic ecosystem EV (called human use EVs)</p> <p>Suitability for drinking water supplies</p> <p>Suitability for primary contact recreation (e.g. swimming)</p> <p>Suitability for secondary contact recreation (e.g. boating)</p> <p>Suitability for visual (no contact) recreation</p> <p>Suitability for human consumers of wild or stocked fish, shellfish or crustaceans (suitability for oystering has also been specifically identified for some Queensland waters)</p> <p>Protection of cultural and spiritual values, including traditional owner values of water</p> <p>Suitability for industrial use (including mining, minerals refining/processing)</p> <p>Suitability for aquaculture (e.g. red claw, barramundi)</p>	✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓	✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓

³ The ADWG are available on the National Health and Medical Research Council website [at www.nhmrc.gov.au](http://www.nhmrc.gov.au).

⁴ The AWQG are available on the Australian Government's National Water Quality Management Strategy website.

Suitability for crop irrigation		✓
Suitability for stock watering		✓
Suitability for farm supply/use		✓

GBRMPA WQG means the *Water Quality Guidelines for the Great Barrier Reef Marine Park, Great Barrier Reef Marine Park Authority 2010*, published at the GBRMPA website.

Level of protection for a water (aquatic ecosystem EV) means the level of aquatic ecosystem condition specified in Table 2 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 goals (if any) stated in section 2 of this document to support the EVs for waters identified in Table 1.

Management intent for a water (aquatic ecosystem EV) is defined in s. 14 of the EPP (Water). It is the management intent for the waters that the decision to release waste water or contaminant to waters must ensure the following:

- for high ecological value (HEV) waters—the measures for the indicators 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 environmental values are progressively improved to achieve the water quality objectives for the water.

QWQG means the Queensland Water Quality Guidelines⁵.

Water quality guidelines (defined in the EPP (Water)) are numerical concentration levels or statements for indicators that protect a stated environmental value. Under the EVs setting process contained in the EPP (Water), 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 2–12 and 14 of this document to support the EVs for waters identified in Table 1.

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.

They are based on scientific criteria or water quality guidelines but may be modified by other inputs (e.g. social, cultural, economic).

Examples of WQOs include:

- total phosphorus concentration less than 20 micrograms per litre (µg/L)

⁵ The QWQG are available on the department's website.

- chlorophyll a concentration less than 1 µg/L
- dissolved oxygen between 95 per cent and 105 per cent saturation
- family richness of macroinvertebrates greater than 12 families
- exotic individuals of fish less than five per cent.

Water type means groupings of waters with similar characteristics, as shown in the accompanying plans. Water types can include fresh waters (lowland, upland, lakes/reservoirs), wetlands and groundwaters, estuarine waters (lower, middle and upper estuaries), tidal canals, constructed estuaries, marinas and boat harbours, and coastal marine waters (open coastal, enclosed coastal). WQOs applying to different water types are outlined in this document. More detail on water types is provided in section 1.5.

Refer to dictionary for additional terms.

1.3.2 Main components of this document

The main components of this document are summarised in the introductory chart (prior to contents) and include the accompanying plans (showing the spatial extent of water types covered by this document) and the following main sections:

- Section 1—introduction and guidance on how to use the document
- Section 2 (table 1)—EVs applying to waters covered by this document
- Section 3 (tables 2–12 and 14)—WQOs applying to different EVs:
 - tables 2 and 14 provide WQOs to protect the aquatic ecosystem EV, and closely link to the water types shown on the accompanying plans
 - tables 3 to 12 provide WQOs to protect human use EVs
- Section 4—ways to improve water quality—containing a list of relevant documents, provided for information purposes only
- Section 5—a dictionary of other terms relevant to EVs and WQOs.

1.3.3 Use of this document

Section 2 (table 1) lists the identified EVs for protection for particular waters. The aquatic ecosystem EV is a default applying to all Queensland waters. Reference to section 3 (tables 2 and 14) provides the corresponding WQOs to protect the aquatic ecosystem EV. For the human use EVs specified in table 1, tables 3 to 12 provide the corresponding WQOs to support these EVs.

Where table 1 indicates 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. Further detail on selection of most stringent WQOs is provided in section 3.

This document also refers to a number of guidelines, codes and other reference sources on water quality. In particular, the QWQG prepared by the department provide a technical basis for the majority of the WQOs contained in this document. The QWQG also provide more detailed information on water types, water quality indicators, derivation of local water quality guidelines, application during flood events, monitoring, and predicting and assessing compliance.

1.4 Information about mapped areas and boundaries

The boundaries in the accompanying plans WQ1271, WQ1272 and WQ1273 are indicative only. EVs, water types and aquatic ecosystem management intent (level of protection) depicted in the accompanying plans are stored in electronic form as part of the Central Queensland Environmental Values Schedule 1 Geodatabase November 2014, and held at the department's offices at 400 George

Street Brisbane. Geodatabase regions are based on the regions established in the QWQG. Spatial (GIS) datasets can be downloaded free of charge from the Queensland Spatial Catalogue (QSpatial) at <http://qldspatial.information.qld.gov.au/catalogue/custom/index.page>. For further information, email the department at epa.ev@ehp.qld.gov.au.

1.5 Water types and basis for boundaries

1.5.1 Water types

Waters in this document have been classified into different water types, including the following (not all water types are present in all areas):

- upland freshwaters—small upstream streams, moderate - fast flowing with steeper gradients than lowland freshwaters. Shown on the accompanying plan as freshwaters above 150 metres altitude
- lowland freshwaters—larger slow moving freshwater streams and rivers, shown on the accompanying plan as freshwaters under 150 metres altitude
- freshwater lakes/reservoirs
- groundwaters
- 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—extending to the seaward limits of Queensland waters.

The water types are based on local water quality studies (refer to the source documents listed after table 2), the AWQG and mapping and definitional rules contained in the QWQG. Further detail on water types is contained in these sources. Water types identified in this document are shown in table 2 and the accompanying plans.

1.5.2 Water type boundaries

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

- geographic coordinates
- catchment or subcatchment boundaries
- highest/lowest astronomical tide
- tidal limiting structure (weirs)
- maritime mapping conventions
- coastline
- surveyed terrestrial boundaries
- altitude
- boundaries based on technical investigations.

Boundaries are shown on the plans. The boundaries of water types may be confirmed or revised by site investigations. Refer to section 1.3 above.

1.6 Matters for amendment

Amendments of the following type may be made to this schedule 1 document for the purposes of replacement under section 12(2)(b) of the EPP (Water):

- 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.

ENVIRONMENTAL VALUES

2 Environmental values

2.1 Environmental values

EVs for waters covered by this document are shown in the accompanying plans (WQ1271, WQ1272, WQ1273) and the following tables:

- table 1A: Styx River Basin and adjacent coastal waters
- table 1B: Shoalwater Creek Basin and adjacent coastal waters
- table 1C: Water Park Creek Basin and adjacent coastal waters.

Details of stakeholder consultation activities carried out by the department and Fitzroy Basin Association (FBA) as input to EVs are reported in:

- Fitzroy Basin Association, 2014, Establishing environmental values and water quality objectives for Capricorn and Curtis Coast basins and coastal waters: draft community consultation report, February 2014.

The dictionary to this document provides further explanation of EVs (refer to section 5).

2.2 Management goals to support environmental values

2.2.1 Management intent for waters

It is the management intent for Queensland waters that the decision to release waste water or contaminant to waters must ensure the following:

- for high ecological value (HEV) waters—the measures for the indicators 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 environmental values are progressively improved to achieve the water quality objectives for the water.

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

Note 2 — see the Environmental Protection Regulation 2008, section 51

Note 3 — see the Environmental Protection (Water) Policy 2009, section 14.

2.2.2 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.

2.2.3 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.

2.2.4 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.

ENVIRONMENTAL VALUES FOR STYX RIVER BASIN AND ADJACENT COASTAL WATERS

Table 1A Environmental values for Styx River Basin and adjacent coastal waters

STYX River Basin	Environmental values ¹⁻⁵											
	Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer	Primary recreation ⁵	Secondary recreation ⁵	Visual recreation	Drinking water	Industrial use	Cultural and spiritual values
Water												
SURFACE FRESH WATERS (rivers, creeks, streams) in developed areas (e.g. urban, industrial, rural residential, agriculture, farmlands)												
Northern Styx fresh waters (including Clairview, St Lawrence and Amity creeks)	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓
Southern Styx fresh waters (including Granite, Toooloombah and Wellington creeks)	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓
Rosewood Island	✓			✓		✓		✓	✓			✓
OTHER FRESH WATERS												
SURFACE FRESH WATERS in undeveloped areas through basin (e.g. in National Parks, State Forests)	✓							✓	✓			✓
GROUNDWATERS (bores, etc.)	✓	✓	✓	✓								✓

12

STYX River Basin	Environmental values ¹⁻⁵											
	Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer	Primary recreation ⁵	Secondary recreation ⁵	Visual recreation	Drinking water	Industrial use	Cultural and spiritual values
Water												
ESTUARIES / BAYS, COASTAL AND MARINE WATERS												
Styx River, St Lawrence, Waverly and other creeks (estuarine reaches)	✓		✓	✓		✓		✓ ⁵	✓			✓
Broad Sound	✓				✓	✓		✓ ⁵	✓			✓
Broad Sound Channel (to the north of Broad Sound)	✓				✓	✓	✓ ⁵	✓ ⁵	✓			✓













Notes:

1. Refer to the accompanying plans WQ1271, WQ1272 and WQ1273 for locations of EVs. For fresh water and estuarine rows, the EVs shown relate to waters within each subcatchment (for example 'Northern Styx fresh waters') as shown on the plans.
2. ✓ means the EV is selected for protection. Blank indicates that the EV is not chosen for protection.
3. Refer to the dictionary for further explanation of EVs.
4. Refer to section 3 for WQOs applying to the EVs in this table.
5. The selection of recreational 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 EHP CrocWatch, council, www.health.qld.gov.au, www.beachsafe.org.au, www.marinestingers.com.au and other information sources for further details on swimming safety and information on specific waters.













ENVIRONMENTAL VALUES FOR

SHOALWATER CREEK BASIN AND ADJACENT COASTAL WATERS

Table 1B Environmental values for Shoalwater Creek Basin and adjacent coastal waters

SHOALWATER CREEK Basin	Environmental values ¹⁻⁶											
	Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer	Primary recreation ⁵	Secondary recreation ⁵	Visual recreation	Drinking water	Industrial use	Cultural and spiritual values
Water												
SURFACE FRESH WATERS (rivers, creeks, streams) in developed areas (e.g. urban, industrial, rural residential, agriculture, farmlands)												
Fresh waters <u>outside</u> Shoalwater Bay Defence Practice Area												
a) Herbert, Banyan and other creeks	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
b) Wadallah, Coonyan and other creeks (lower reaches)	✓		✓	✓		✓					✓	✓
c) Island fresh waters (to north/east – e.g. Duke Is group, Long, Quail, Holt, Swan islands)	✓			✓	✓							✓
Fresh waters <u>within</u> Shoalwater Bay Defence Practice Area[#] (including upper reaches of Coonyan, Wadallah, Tilpal, Shoalwater and Louisa creeks and any fresh waters on adjacent islands within DPA)	✓		✓						✓	✓		✓
OTHER FRESH WATERS												
SURFACE FRESH WATERS in undeveloped areas through basin (e.g. in National Parks)	✓								✓			✓
GROUNDWATERS (bores, etc.)	✓			✓						✓		✓

15

SHOALWATER CREEK Basin	Environmental values ¹⁻⁶											
	Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer	Primary recreation ⁵	Secondary recreation ⁵	Visual recreation	Drinking water	Industrial use	Cultural and spiritual values
Water												
ESTUARIES / BAYS, COASTAL AND MARINE WATERS												
Herbert, Wadallah/Coonyan and other creeks (estuarine reaches)	✓					✓		✓ ⁵	✓			✓
Broad Sound	✓				✓	✓		✓ ⁵	✓			✓
Shoalwater Bay [#] (includes North West Channel, West Bight)	✓					✓ [#]	✓ ^{#5}	✓ ^{#5}	✓ [#]	✓ ⁶		✓
Broad Sound channel	✓				✓	✓	✓ ⁵	✓ ⁵	✓			✓

Notes:













#: Access limitations apply to land portions of Shoalwater Bay Training Area (SWBTA) at all times, and unauthorised access is prohibited. During military operations access restrictions apply to areas (including islands, estuarine and marine waters) within the broader Shoalwater Bay Defence Practice Area (DPA). These are issued as a Notice to Mariners (NOTMAR), and are available from the Maritime Services Queensland website at <http://www.msq.qld.gov.au/Notices-to-Mariners.aspx>.

1. Refer to the accompanying plans WQ1271, WQ1272 and WQ1273 for locations of EVs. For fresh water and estuarine rows, the EVs shown relate to waters within each subcatchment (for example 'Herbert, Banyan and other creeks') as shown on the plans.
2. ✓ means the EV is selected for protection. Blank indicates that the EV is not chosen for protection.
3. Refer to the dictionary for further explanation of EVs.
4. Refer to section 3 for WQOs applying to the EVs in this table.
5. The selection of recreational 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 EHP CrocWatch, council, www.health.qld.gov.au, www.beachsafe.org.au, www.marinestingers.com.au and other information sources for further details on swimming safety and information on specific waters.
6. Waters in which desalination for drinking water may apply (defence purposes).













ENVIRONMENTAL VALUES FOR

WATER PARK CREEK BASIN AND ADJACENT COASTAL WATERS

Table 1C Environmental values for Water Park Creek Basin and adjacent coastal waters

WATER PARK CREEK Basin	Environmental values ¹⁻⁶											
	Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer	Primary recreation ⁵	Secondary recreation ⁵	Visual recreation	Drinking water	Industrial use	Cultural and spiritual values
Water												
SURFACE FRESH WATERS (rivers, creeks, streams) in developed areas (e.g. urban, industrial, rural residential, agriculture, farmlands)												
Fresh waters <u>outside</u> Shoalwater Bay Defence Practice Area												
Fresh waters east of Water Park Creek	✓		✓	✓		✓	✓	✓	✓	✓		✓
Fresh waters west of Water Park Creek	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water Park Creek main channel (including Waterpark Creek weir)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fresh waters between Corio Bay and Yeppoon	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Fresh waters between Yeppoon and Keppel Sands	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fresh waters south of Keppel Sands to Fitzroy mouth	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Island fresh waters (Great Keppel, others)	✓	✓				✓	✓	✓	✓	✓	✓	✓
Fresh waters <u>within</u> Shoalwater Bay Defence Practice Area[#] (including Georges, Sandy and Tea Tree creeks)	✓		✓						✓	✓		✓
GROUNDWATERS (bores, etc.)	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓

18

WATER PARK CREEK Basin	Environmental values ¹⁻⁶											
	Aquatic ecosystems	Irrigation	Farm supply/use	Stock water	Aquaculture	Human consumer	Primary recreation ⁵	Secondary recreation ⁵	Visual recreation	Drinking water	Industrial use	Cultural and spiritual values
Water												
ESTUARIES / BAYS												
Shoalwater Bay #	✓					✓#	✓#5	✓#5	✓#	✓ ⁶		✓
Estuaries <u>within</u> Shoalwater Bay Defence Practice Area #	✓					✓	✓#5	✓#5	✓	✓ ⁶		✓
Estuaries outside Shoalwater Bay Defence Practice Area												
Water Park Creek (estuarine reaches) / Corio Bay	✓					✓		✓ ⁵	✓			✓
Ross/Yeppoon Creeks (estuarine reaches)	✓					✓		✓ ⁵	✓		✓	✓
Rosslyn Bay	✓					✓	✓ ⁵	✓ ⁵	✓		✓	✓
Coorooman and Shoal creeks (estuarine reaches) and Causeway Lake	✓				✓	✓		✓ ⁵	✓	✓		✓
COASTAL AND MARINE WATERS												
Swain Reefs waters	✓					✓	✓	✓	✓			✓
Coastal waters in and seaward of Shoalwater Bay Defence Practice Area #	✓				✓#	✓#	✓#5	✓#5	✓#			✓
Keppel Bay coastal waters (south from Shoalwater Bay Defence Practice Area to Port limits)	✓				✓	✓	✓ ⁵	✓ ⁵	✓		✓	✓

Notes:

#: Access limitations apply to land portions of Shoalwater Bay Training Area (SWBTA) at all times, and unauthorised access is prohibited. During military operations access restrictions apply to areas (including islands, estuarine and marine waters) within the broader Shoalwater Bay Defence Practice Area (DPA). These are issued as a Notice to Mariners (NOTMAR), and are available from the Maritime Services Queensland website at <http://www.msq.qld.gov.au/Notices-to-Mariners.aspx>.

1. Refer to the accompanying plans WQ1271, WQ1272 and WQ1273 for locations of EVs. For fresh water and estuarine rows, the EVs shown relate to waters within each subcatchment (for example 'Fresh waters east of Waterpark Creek') as shown on the plans.

2. ✓ means the EV is selected for protection. Blank indicates that the EV is not chosen for protection.

3. Refer to the dictionary for further explanation of EVs.

4. Refer to section 3 for WQOs applying to the EVs in this table.

5. The selection of recreational 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 EHP CrocWatch, council, www.health.qld.gov.au, www.beachsafe.org.au, www.marinestingers.com.au and other information sources for further details on swimming safety and information on specific waters.

6. Waters in which desalination for drinking water may apply (defence purposes).

WATER QUALITY OBJECTIVES TO PROTECT ENVIRONMENTAL VALUES

3 Water quality objectives to protect environmental values

This section provides WQOs to support and protect different EVs identified for waters in table 1. 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.

Aquatic ecosystem WQOs

This section is in two main parts

- Section 3.1 (tables 2 and 14) outlines WQOs to protect the aquatic ecosystem EV.

Main tables are:

- table 2A: Styx River Basin and adjacent coastal waters
- table 2B: Shoalwater Creek Basin and adjacent coastal waters
- table 2C: Water Park Creek Basin and adjacent coastal waters
- table 14: Surface and groundwater WQOs (ionic indicators)

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.

Human use EVs

Section 3.2 (tables 3 to 12) provides WQOs for EVs other than aquatic ecosystem ('human use EVs') such as recreational water use, irrigating crops, and aquaculture.

Sources used in deriving WQOs are provided in and after the tables.

Where reference to table 1 indicates more than one EV applies to a given water (for example aquatic ecosystem and recreational use), the most stringent WQO for each water quality indicator applies, which will then protect all identified EVs. Refer to the following example on selection of most stringent WQOs. Note that this is an example only and should not be directly adopted for use.

Example

For lowland freshwater streams with aquatic ecosystem and drinking water EVs, the respective turbidity WQOs are:

- aquatic ecosystem lowland freshwater stream: less than 10 nephelometric turbidity units (NTU)
- drinking water: less than 25 NTU.

In this case the aquatic ecosystem WQO for turbidity (less than 10 NTU) is the more stringent, and its adoption therefore supports both the aquatic ecosystem and drinking water EVs.

3.1 Water quality objectives to protect aquatic ecosystems

This section provides physico-chemical, biological (section 3.1.1) and riparian (section 3.1.2) WQOs to support the aquatic ecosystem EV. Sources used in deriving locally relevant WQOs are provided in and after the tables in each of these sections. Section 3.1.3 provides information about the State Planning Policy (SPP) (state interest – water quality).

3.1.1 Physico–chemical and biological water quality objectives

Table 2 includes the following information:

- water area or water type (column 1) (for boundaries of specified areas, refer to the accompanying plans)
- the corresponding management intent (level of protection) for the identified waters (column 2)
- the corresponding physico-chemical and biological WQOs to achieve the management intent (level of protection) for the identified waters (column 3).

Waters for which all physico-chemical WQOs (e.g. nutrients, toxicants) have been set corresponding to HEV management intent are identified in columns 1 and 2 of Table 2. Each of these waters is given a specific label in the table (e.g. 'HEV1234') which links to the accompanying plans. Slightly disturbed (SD) waters are similarly identified.

The management intent (level of protection) for most waters other than HEV or SD is to achieve a 'moderately disturbed' (MD) condition, for which corresponding WQOs have been derived. Where local WQOs are derived for MD areas these are also identified with specific labels (e.g. 'MD1234'). For some indicators and water types, WQOs correspond with a 'slightly to moderately disturbed' (SMD) level of protection, based on management intent categories specified in source technical guidelines, in particular the Australian water quality guidelines (ANZECC, 2000). For ease of interpretation, this document and accompanying mapping include these within the MD level of protection. For some MD waters a higher level of protection may be provided for toxicants (e.g. pesticides).

WQOs for metals and other toxicants, where not stated in this document, are referred to the ANZECC guidelines. In the case of aluminium, reference is made to a recent peer reviewed study of toxicity of aluminium in marine waters by Golding et al. (2014). This study used ANZECC protocols to derive a marine guideline value of 24 µg/L of aluminium (that applies to the measured concentration of seawater that passes through a 0.45 µm filter) to protect 95% of species (with a 99% species protection value of 2.1 µg/L). This supersedes the existing low reliability guideline of 0.5 µg/L which was derived using conservative safety margins from limited data.

Source: Golding, L.A., Angel, B.M., Batley, G.E., Apte, S.C., Krassoi, R. and Doyle, C.J. 2014. Derivation of a water quality guideline for aluminium in marine waters. *Environmental Toxicology and Chemistry* (Accepted) (DOI: 10.1002/etc.2771).

Application

The QWQG (section 5, Appendix D) address procedures for the application of guidelines for aquatic ecosystem protection, and compliance assessment protocols. For the comparison of test site monitoring data against WQOs, the median water quality value (e.g. concentration) of a number (preferably five or more) of independent samples at a particular monitoring ('test') site should be compared against the water quality objective of the same indicator, water type and level of aquatic ecosystem protection, as listed in table 2 below.

For WQOs based on GBRMPA data, where single value WQOs are given for specified indicators (e.g. particulate N, Secchi depth), these should be compared to annual mean (rather than median) values. Relevant seasonal adjustments can be referenced in GBRMPA (2010) Water quality guidelines for the Great Barrier Reef Marine Park 2010. Also refer to notes after the tables.

AQUATIC ECOSYSTEM EV

WATER QUALITY OBJECTIVES FOR STYX RIVER BASIN AND ADJACENT COASTAL WATERS

Table 2A Styx River Basin and adjacent coastal waters: Water quality objectives to protect aquatic ecosystem environmental value under baseflow conditions

Water area/type	Management intent /level of protection	STYX: Baseflow water quality objectives (WQOs) ¹⁻⁷										
		Note: WQOs for indicators are shown as 20 th , 50 th and 80 th percentiles (e.g. 3–4–5), lower and upper limits (20 th /80 th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80 th percentile) (e.g. <15). HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed										
		Amm N (µg/L)	Oxid N (µg/L)	Total N (µg/L)	FRP (µg/L)	Total P (µg/L)	Chl-a (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)	pH
STYX FRESH WATERS												
Upland fresh >150m (s2)	MD	<10	<15	<250	<15	<30	na	90–110	<25	-	id	6.5–7.5
Lowland fresh <150m (s2)	MD	<20	<60	<500	<20	<50	<5	85–110	<50	-	<10	6.5–8.0
Lakes / reservoirs (s2)	MD	<10	<10	<350	<5	<10	<5	90–110	1–20	-	id	6.5–8.0
All fresh waters: toxicants (s5)	MD	Toxicants in water and sediment as per AWQG: <ul style="list-style-type: none"> Toxicants in water: refer to AWQG volume 1 section 3.4—'water quality guidelines for toxicants' (including tables 3.4.1, 3.4.2, and Figure 3.4.1), and AWQG volume 2 (section 8). AWQG values for the MD level of protection typically correspond to protection of 95% species (in a small number of cases where bioaccumulation may occur, the AWQG recommends 99% species protection level). Toxicants in sediments: refer to AWQG volume 1 section 3.5—'sediment quality guidelines' (including Table 3.5.1, Figure 3.5.1), and AWQG volume 2 (section 8) Anti-fouling: Comply with <i>Anti-fouling and in-water cleaning guidelines</i> (June 2013)										
WETLANDS (s5)	all	id	id	id	id	id	id	id	id	id	id	id
RIPARIAN	all	Refer to section 3.1.2										
GROUND WATERS (s1)	HEV	WQOs are provided according to their chemistry zone and depth category in Table 14 (refer plan WQ1273). Where groundwaters interact with surface waters, groundwater quality should not compromise identified EVs and WQOs for those waters. Note: the AWQG recommends that the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value. Where groundwaters are in good condition the intent is to maintain existing water quality (20th, 50th and 80th percentiles).										

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	STYX: Baseflow water quality objectives (WQOs) ^{1–7}										
		<p>Note: WQOs for indicators are shown as 20th, 50th and 80th percentiles (e.g. 3–4–5), lower and upper limits (20th/80th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80th percentile) (e.g. <15).</p> <p>HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed</p>										
		Amm N (µg/L)	Oxid N (µg/L)	Total N (µg/L)	FRP (µg/L)	Total P (µg/L)	Chl-a (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)	pH
STYX ESTUARINE WATERS												
SD2422 Middle estuary (s2)	HEV	3–6–10	2–3–10	130–200–300	3–5–8	12–16–25	1.5–2.5–4.0	85–90–100	id	id	id	7.0–8.4
Middle estuary (all others) (s2)	MD	<10	<10	<300	<8	<25	<4	85–100	id	id	id	7.0–8.4
Estuaries: toxicants (s5)	all	<p>Toxicants in water and sediment as per AWQG:</p> <ul style="list-style-type: none"> Toxicants in water: refer to AWQG volume 1 section 3.4—‘water quality guidelines for toxicants’ (including tables 3.4.1, 3.4.2, and Figure 3.4.1), and AWQG volume 2 (section 8, including section 8.3.4.4 on application in estuarine waters) Toxicants in sediments: refer to AWQG volume 1 section 3.5—‘sediment quality guidelines’ (including Table 3.5.1, Figure 3.5.1), and AWQG volume 2 (section 8) <p>Sewage: Release of sewage from vessels to be controlled in accordance with requirements of the Transport Operations (Marine Pollution) Act 1995 and Regulations. (Refer to Maritime Services Queensland website for further information.)</p> <p>Anti-fouling: Comply with <i>Anti-fouling and in-water cleaning guidelines</i> (June 2013)</p>										
Estuaries: biological	all	<p><u>Seagrass:</u> Minimum light requirement is a photosynthetic active radiation (PAR) two week moving average of greater than 6 mol m⁻² day⁻¹. This is minimum requirement only and is generally below the current average conditions of the harbour. It does not include potential impacts on benthic microalgae and phytoplankton at this light level. Objective based on Chartrand et al. (2012) <i>Development of a Light-Based Seagrass Management Approach for the Gladstone Western Basin Dredging Program</i>.</p> <p><u>Mangroves:</u> No loss of mangrove area. EHP/ Queensland Herbarium conducts biennial mapping of mangrove cover and this could be used as an assessment tool. Mapping is available from EHP.</p>										

Sources: S1: Local datasets (e.g. DSITIA, key stakeholder); S2: QWQG guidelines and /or data; S3:GBRMPA (2010) WQG; S4: GBRMPA analysis of Reef Rescue Marine Monitoring Program and/or Long Term Monitoring Program datasets; S5: ANZECC (2000) AWQG

Notes 1–7: Refer notes after Table 2C.

Table 2A continued

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	STYX COASTAL WATERS: Water quality objectives (WQOs) ¹⁻⁷															
		Note: WQOs for indicators are shown as 20 th , 50 th and 80 th percentiles (e.g. 3–4–5), lower and upper limits (20 th /80 th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80 th percentile) (e.g. <15).															
		HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed															
		Amm N (µg/L)	Oxid N (µg/L)	Partic N (µg/L)	Total Diss N (µg/L)	Total N (µg/L)	FRP (µg/L)	Partic P (µg/L)	Total Diss P (µg/L)	Total P (µg/L)	Chl-a (µg/L)	Silicate (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)	pH
STYX COASTAL and MARINE WATERS																	
SD2422 Lower estuary/ enclosed coastal waters Broadsound (s2)	HEV	2–3–8	2–2–3	-	-	100–130–200	2–2–6	-	-	6–9–20	0.5–1.0–2.0	-	90–95– 100	id	id	id	8.0–8.4
Lower estuary/ enclosed coastal waters (all other) (s2)	MD	<8	<3	-	-	<200	<6	-	-	<20	<2	-	90–100	id	id	id	8.0–8.4
SD2421 Broadsound Open coastal waters (s3, s4)	HEV	1–2–6	0–0–1	≤20 (ann. mean)	45–75–105	60–90–130	1–2–4	≤2.8 (ann. mean)	4–9–17	6–12–20	≤0.45 (ann. mean)	40–60– 100	95–105	id	≥8	≤2.4 (ann. mean)	8.1–8.3– 8.4
Coastal and marine waters (s3)	all	Temperature: increases of no more than 1°C above long-term (20 year) average maximum (GBRMPA, 2010)															

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	STYX COASTAL WATERS: Water quality objectives (WQOs) ¹⁻⁷														
		<p>Note: WQOs for indicators are shown as 20th, 50th and 80th percentiles (e.g. 3–4–5), lower and upper limits (20th/80th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80th percentile) (e.g. <15).</p> <p>HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed</p>														
		Amm N (µg/L)	Oxid N (µg/L)	Partic N (µg/L)	Total Diss N (µg/L)	Total N (µg/L)	FRP (µg/L)	Partic P (µg/L)	Total Diss P (µg/L)	Total P (µg/L)	Chl-a (µg/L)	Silicate (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)
Coastal waters outside ports, marinas, spoil grounds: toxicants (s3, s5)	all	<p>WQOs for all toxicants in these waters as per GBRMPA and AWQG water quality guidelines (except Aluminium, specified below), to protect marine species at the HEV level of protection. Pesticides/biocides specified in GBR water quality guidelines include:</p> <ul style="list-style-type: none"> • Ametryn: <0.5 µg/L; Atrazine: <0.6 µg/L; Diuron: <0.9 µg/L; Hexazinone: <1.2 µg/L; Simazine: <0.2 µg/L; Tebuthiuron: <0.02 µg/L; 2,4-D: <0.8 µg/L; Tributyltin: <0.0004 µg/L <p>For other toxicants not listed in GBRMPA guidelines, refer to AWQG and sources below:</p> <ul style="list-style-type: none"> • Toxicants in water: refer to AWQG section 3.4—‘water quality guidelines for toxicants’ (including tables 3.4.1, 3.4.2, and Figure 3.4.1), and AWQG volume 2 (section 8). Values correspond to protection of 99% species • Aluminium: <2.1 µg/L (Source: Golding, LA, Angel, BM, Batley, GE, Apte, SC, Krassoi, R and Doyle, CJ (2014) Derivation of a water quality guideline for aluminium in marine waters, <i>Environ Toxicol Chem.</i>, Accepted Article DOI: 10.1002/etc.2771, accepted 3 October 2014 • Toxicants in sediments: refer to AWQG section 3.5—‘sediment quality guidelines’ (including Table 3.5.1, Figure 3.5.1), and AWQG volume 2 (section 8) <p>Sewage: Release of sewage from vessels to be controlled in accordance with requirements of the Transport Operations (Marine Pollution) Act 1995 and Regulations. (Refer to Maritime Services Queensland website for further information.)</p> <p>Anti-fouling: Comply with <i>Anti-fouling and in-water cleaning guidelines</i> (June 2013)</p>														
Coastal waters in ports, marinas, spoil grounds: toxicants (s3, s5)	all	<p>Pesticides:</p> <p>WQOs for all pesticides in these waters as per GBRMPA and AWQG water quality guidelines, to protect marine species at the HEV level of protection (except where noted). Pesticides/biocides specified in GBR water quality guidelines include:</p> <ul style="list-style-type: none"> • Ametryn: <0.5 µg/L; Atrazine: <0.6 µg/L; Diuron: <0.9 µg/L; Hexazinone: <1.2 µg/L; Simazine: <0.2 µg/L; Tebuthiuron: <0.02 µg/L; 2,4-D: <0.8 µg/L ; Tributyltin: <0.006 µg/L (95% species protection) <p>For other toxicants not listed in GBRMPA guidelines, refer to AWQG:</p> <ul style="list-style-type: none"> • Toxicants in water: refer to AWQG volume 1 section 3.4—‘water quality guidelines for toxicants’ (including tables 3.4.1, 3.4.2, and Figure 3.4.1), and AWQG volume 2 (section 8). AWQG values for the MD level of protection typically correspond to protection of 95% species (in a small number of cases where bioaccumulation may occur, the AWQG recommends 99% species protection level). • Aluminium: <24 µg/L (Source: Golding, LA, Angel, BM, Batley, GE, Apte, SC, Krassoi, R and Doyle, CJ (2014) Derivation of a water quality guideline for aluminium in marine waters, <i>Environ Toxicol Chem.</i>, Accepted Article DOI: 10.1002/etc.2771, accepted 3 October 2014 • Toxicants in sediments: refer to AWQG volume 1 section 3.5—‘sediment quality guidelines’ (including Table 3.5.1, Figure 3.5.1), and AWQG volume 2 (section 8) <p>Sewage: Release of sewage from vessels to be controlled in accordance with requirements of the Transport Operations (Marine Pollution) Act 1995 and Regulations. (Refer to Maritime Services Queensland website for further information.)</p> <p>Anti-fouling: Comply with <i>Anti-fouling and in-water cleaning guidelines</i> (June 2013)</p>														

Water area/type	Management intent /level of protection	STYX COASTAL WATERS: Water quality objectives (WQOs) ¹⁻⁷														
		<p>Note: WQOs for indicators are shown as 20th, 50th and 80th percentiles (e.g. 3–4–5), lower and upper limits (20th/80th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80th percentile) (e.g. <15).</p> <p>HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed</p>														
		Amm N (µg/L)	Oxid N (µg/L)	Partic N (µg/L)	Total Diss N (µg/L)	Total N (µg/L)	FRP (µg/L)	Partic P (µg/L)	Total Diss P (µg/L)	Total P (µg/L)	Chl-a (µg/L)	Silicate (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)
Coastal waters: biological	all	<p><u>Seagrass:</u> Minimum light requirement is a photosynthetic active radiation (PAR) two week moving average of greater than 6 mol m⁻² day⁻¹. This is minimum requirement only and is generally below the current average conditions of the harbour. It does not include potential impacts on benthic microalgae and phytoplankton at this light level. Objective based on Chartrand et al. (2012) <i>Development of a Light-Based Seagrass Management Approach for the Gladstone Western Basin Dredging Program</i>.</p> <p><u>Mangroves:</u> No loss of mangrove area. EHP/ Queensland Herbarium conducts biennial mapping of mangrove cover and this could be used as an assessment tool. Mapping is available from EHP.</p>														

Sources: S1: Local datasets (e.g. DSITIA, key stakeholder); S2: QWQG guidelines and /or data; S3: GBRMPA (2010) WQG; S4: GBRMPA analysis of Reef Rescue Marine Monitoring Program and/or Long Term Monitoring Program datasets; S5: ANZECC (2000) AWQG

Notes 1 –7: Refer notes after Table 2C.

AQUATIC ECOSYSTEM EV

WATER QUALITY OBJECTIVES FOR SHOALWATER CREEK BASIN AND ADJACENT COASTAL WATERS

Table 2B Shoalwater Creek Basin and adjacent coastal waters: Water quality objectives to protect aquatic ecosystem environmental value under baseflow conditions

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	SHOALWATER: Baseflow water quality objectives (WQOs) ¹⁻⁷										
		Note: WQOs for indicators are shown as 20 th , 50 th and 80 th percentiles (e.g. 3–4–5), lower and upper limits (20 th /80 th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80 th percentile) (e.g. <15). HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed										
		Amm N (µg/L)	Oxid N (µg/L)	Total N (µg/L)	FRP (µg/L)	Total P (µg/L)	Chl-a (µg/L)	DO (% sat)	Turb (NTU)	SS (mg/L)	EC (µS/cm)	pH
SHOALWATER FRESH WATERS												
HEV2401, 2421 SD2422 (national parks, fish habitat area)	HEV	Insufficient data. Refer to QWQG for details on how to establish local WQOs										
HEV2402 (Shoalwater Bay Defence western creeks) (s1)	HEV	<20 (DO>80%) <30 (DO 40–80%) <60 (DO<40%)	2–2–5	410–500–960	2–4–7	28–38–50	0.5–3–9	Refer Amm N	10–30–50	-	155–190–245	6.0–7.0
HEV2403 (Shoalwater Bay Defence eastern, southern creeks) (s1)	HEV	<20 (DO>80%) <30 (DO 40–80%) <60 (DO<40%)	2–2–5	180–350–620	2–2–3	14–20–28	0.5–1–4	Refer Amm N	6–17–30	-	155–190–245	5.5–7
Shoalwater Bay Defence sand aquifer creeks (in HEV2403) (s1)	HEV	6–12–17	40–58–76	260–360–400	2–2–2	3–9–10	<0.5–<0.5–<0.5	85–90–95	2–3–4	-	130–130–145	4–5

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	SHOALWATER: Baseflow water quality objectives (WQOs) ¹⁻⁷										
		<p>Note: WQOs for indicators are shown as 20th, 50th and 80th percentiles (e.g. 3–4–5), lower and upper limits (20th/80th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80th percentile) (e.g. <15).</p> <p>HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed</p>										
		Amm N (µg/L)	Oxid N (µg/L)	Total N (µg/L)	FRP (µg/L)	Total P (µg/L)	Chl-a (µg/L)	DO (% sat)	Turb (NTU)	SS (mg/L)	EC (µS/cm)	pH
HEV and SD fresh waters: toxicants (s5)	HEV	<p>Toxicants in water and sediment as per AWQG:</p> <ul style="list-style-type: none"> Toxicants in water: refer to AWQG volume 1 section 3.4—‘water quality guidelines for toxicants’ (including tables 3.4.1, 3.4.2, and Figure 3.4.1), and AWQG volume 2 (section 8). AWQG values for the HEV level of protection correspond to protection of 99% species Toxicants in sediments: refer to AWQG volume 1 section 3.5—‘sediment quality guidelines’ (including Table 3.5.1, Figure 3.5.1), and AWQG volume 2 (section 8) <p>Anti-fouling: Comply with <i>Anti-fouling and in-water cleaning guidelines</i> (June 2013)</p>										
Upland fresh >150m (s2)	MD	<10	<15	<250	<15	<30	na	90–110	<25	id	-	6.5–7.5
Lowland fresh <150m (s2)	MD	<20	<60	<500	<20	<50	<5	85–110	<50	<10	-	6.5–8.0
MD2401 Herbert, Tilpal creeks (s1, s2)	MD	As for lowland fresh waters (row above) with the following local WQOs:									Herb: <540 Til: <710	Herb: 6.9–7.5 Til: 7.0–7.9
Lakes / reservoirs (s2)	MD	<10	<10	<350	<5	<10	<5	90–110	1–20	id	-	6.5–8.0
Fresh waters: macro-invertebrates (s1)	all	<ul style="list-style-type: none"> Taxa richness: 19–23 (taxa richness is the number of aquatic macroinvertebrates collected in a sample) Average SIGNAL grade: 3.18–3.38 (SIGNAL: stream invertebrate grade number – average level; version 2.iv) % tolerant taxa: 35.00–41.38% (tolerant taxa is based on the proportion of taxa with ‘tolerant’ sensitivity grades (SIGNAL grades 1,2, 3) <p>(Note: limited datasets. Values may vary with additional datasets)</p>										
Fresh waters: toxicants (s5)	MD	<p>Toxicants in water and sediment as per AWQG:</p> <ul style="list-style-type: none"> Toxicants in water: refer to AWQG volume 1 section 3.4—‘water quality guidelines for toxicants’ (including tables 3.4.1, 3.4.2, and Figure 3.4.1), and AWQG volume 2 (section 8). AWQG values for the MD level of protection typically correspond to protection of 95% species (in a small number of cases where bioaccumulation may occur, the AWQG recommends 99% species protection level). Toxicants in sediments: refer to AWQG volume 1 section 3.5—‘sediment quality guidelines’ (including Table 3.5.1, Figure 3.5.1), and AWQG volume 2 (section 8) <p>Anti-fouling: Comply with <i>Anti-fouling and in-water cleaning guidelines</i> (June 2013)</p>										

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	SHOALWATER: Baseflow water quality objectives (WQOs) ¹⁻⁷										
		<p>Note: WQOs for indicators are shown as 20th, 50th and 80th percentiles (e.g. 3–4–5), lower and upper limits (20th/80th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80th percentile) (e.g. <15).</p> <p>HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed</p>										
		Amm N (µg/L)	Oxid N (µg/L)	Total N (µg/L)	FRP (µg/L)	Total P (µg/L)	Chl-a (µg/L)	DO (% sat)	Turb (NTU)	SS (mg/L)	EC (µS/cm)	pH
Eastern Shoalwater fresh waters: ionic indicators	all	Refer to additional ionic indicators in Table 14 (from DSITIA analyses), where not included above										
WETLANDS (s5)	all	id	id	id	id	id	id	id	id	id-	-	id
RIPARIAN	all	Refer to section 3.1.2										
GROUND WATERS (s1)	HEV	WQOs are provided according to their chemistry zone and depth category in Table 14 (refer plan WQ1273). Where groundwaters interact with surface waters, groundwater quality should not compromise identified EVs and WQOs for those waters. Note: the AWQG recommends that the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value. Where groundwaters are in good condition the intent is to maintain existing water quality (20th, 50th and 80th percentiles).										

Sources: S1: Local datasets (e.g. DSITIA, key stakeholder); S2: QWQG guidelines and /or data; S3:GBRMPA (2010) WQG; S4: GBRMPA analysis of Reef Rescue Marine Monitoring Program and/or Long Term Monitoring Program datasets; S5: ANZECC (2000) AWQG

Notes1-7: Refer notes after Table 2C.

Water area/type	Management intent /level of protection	SHOALWATER: Baseflow water quality objectives (WQOs) ¹⁻⁷										
		<p>Note: WQOs for indicators are shown as 20th, 50th and 80th percentiles (e.g. 3–4–5), lower and upper limits (20th/80th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80th percentile) (e.g. <15).</p> <p>HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed</p>										
		Amm N (µg/L)	Oxid N (µg/L)	Total N (µg/L)	FRP (µg/L)	Total P (µg/L)	Chl-a (µg/L)	DO (% sat)	Turb (NTU)	SS (mg/L)	EC (µS/cm)	pH
SHOALWATER ESTUARINE WATERS												
HEV2403 Middle estuary in Shoalwater Bay Defence (s2)	HEV	3–6–10	2–3–10	130–200–300	3–5–8	12–16–25	1.5–2.5–4.0	85–90–100	id	id	-	7.0–8.4
SD2422 Middle estuary (s2)	HEV	3–6–10	2–3–10	130–200–300	3–5–8	12–16–25	1.5–2.5–4.0	85–90–100	id	id	-	7.0–8.4
Middle estuary (all others) (s2)	MD	<10	<10	<300	<8	<25	<4	85–100	id	id	-	7.0–8.4
Estuaries: toxicants (s5)	all	<p>Toxicants in water and sediment as per AWQG:</p> <ul style="list-style-type: none"> Toxicants in water: refer to AWQG volume 1 section 3.4—'water quality guidelines for toxicants' (including tables 3.4.1, 3.4.2, and Figure 3.4.1), and AWQG volume 2 (section 8, including section 8.3.4.4 on application in estuarine waters) Toxicants in sediments: refer to AWQG volume 1 section 3.5—'sediment quality guidelines' (including Table 3.5.1, Figure 3.5.1), and AWQG volume 2 (section 8) <p>Sewage: Release of sewage from vessels to be controlled in accordance with requirements of the Transport Operations (Marine Pollution) Act 1995 and Regulations. (Refer to Maritime Services Queensland website for further information.)</p> <p>Anti-fouling: Comply with <i>Anti-fouling and in-water cleaning guidelines</i> (June 2013)</p>										
Estuaries: biological	all	<p><u>Seagrass:</u> Minimum light requirement is a photosynthetic active radiation (PAR) two week moving average of greater than 6 mol m⁻² day⁻¹. This is minimum requirement only and is generally below the current average conditions of the harbour. It does not include potential impacts on benthic microalgae and phytoplankton at this light level. Objective based on Chartrand et al. (2012) <i>Development of a Light-Based Seagrass Management Approach for the Gladstone Western Basin Dredging Program</i>.</p> <p><u>Mangroves:</u> No loss of mangrove area. EHP/ Queensland Herbarium conducts biennial mapping of mangrove cover and this could be used as an assessment tool. Mapping is available from EHP.</p>										

Sources: S1: Local datasets (e.g. DSITIA, key stakeholder); S2: QWQG guidelines and /or data; S3:GBRMPA (2010) WQG; S4: GBRMPA analysis of Reef Rescue Marine Monitoring Program and/or Long Term Monitoring Program datasets; S5: ANZECC (2000) AWQG

Notes 1–7: Refer notes after Table 2C.

Table 2B continued

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	SHOALWATER COASTAL WATERS: Water quality objectives (WQOs) ¹⁻⁷															
		Note: WQOs for indicators are shown as 20 th , 50 th and 80 th percentiles (e.g. 3–4–5), lower and upper limits (20 th /80 th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80 th percentile) (e.g. <15). HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed															
		Amm N (µg/L)	Oxid N (µg/L)	Partic N (µg/L)	Total Diss N (µg/L)	Total N (µg/L)	FRP (µg/L)	Partic P (µg/L)	Total Diss P (µg/L)	Total P (µg/L)	Chl-a (µg/L)	Silicate (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)	pH
SHOALWATER COASTAL and MARINE WATERS																	
HEV2426 Lower estuary/ enclosed coastal waters Shoalwater Bay (s2)	HEV	2–3–8	2–2–3	-	-	100–130–200	2–2–6	-	-	6–9–20	0.5–1.0–2.0	-	90–95–100	id	id	id	8.0–8.4
SD2422 Lower estuary/ enclosed coastal waters Broadsound (s2)	HEV	2–3–8	2–2–3	-	-	100–130–200	2–2–6	-	-	6–9–20	0.5–1.0–2.0	-	90–95–100	id	id	id	8.0–8.4
HEV2423 Coastal waters east of Stange (s4, s3, s2)	HEV	1–2–6	0–0–1	≤20 (ann. mean)	45–75–105	60–90–130	1–2–4	≤2.8 (ann. mean)	4–9–17	6–12–20	≤0.45 (ann. mean)	40–60– 100	95–105	id	≥10 (ann. mean)	≤2 (ann. mean)	8.1–8.3–8.4
HEV2425 Open coastal macro-tidal waters in Shoalwater Bay (s4, s3, s2)	HEV	1–2–6	0–0–1	≤20 (ann. mean)	45–75–105	60–90–130	1–2–4	≤2.8 (ann. mean)	4–9–17	6–12–20	≤0.45 (ann. mean)	40–60– 100	95–105	id	≥8 (ann. mean)	≤2.4 (ann. mean)	8.1–8.3–8.4
Coastal and marine waters (s3)	all	Temperature: increases of no more than 1°C above long-term (20 year) average maximum. (GBRMPA, 2010)															

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	SHOALWATER COASTAL WATERS: Water quality objectives (WQOs) ^{1–7}														
		<p>Note: WQOs for indicators are shown as 20th, 50th and 80th percentiles (e.g. 3–4–5), lower and upper limits (20th/80th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80th percentile) (e.g. <15).</p> <p>HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed</p>														
		Amm N (µg/L)	Oxid N (µg/L)	Partic N (µg/L)	Total Diss N (µg/L)	Total N (µg/L)	FRP (µg/L)	Partic P (µg/L)	Total Diss P (µg/L)	Total P (µg/L)	Chl-a (µg/L)	Silicate (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)
Coastal waters outside ports, marinas, spoil grounds: toxicants (s3, s5)	all	<p>WQOs for all toxicants in these waters as per GBRMPA and AWQG water quality guidelines, to protect marine species at the HEV level of protection.</p> <p>Pesticides/biocides specified in GBR water quality guidelines include:</p> <ul style="list-style-type: none"> • Ametryn: <0.5 µg/L; Atrazine: <0.6 µg/L; Diuron: <0.9 µg/L; Hexazinone: <1.2 µg/L; Simazine: <0.2 µg/L; Tebuthiuron: <0.02 µg/L; 2,4-D: <0.8 µg/L; Tributyltin: <0.0004 µg/L <p>For other toxicants not listed in GBRMPA guidelines, refer to AWQG and sources below:</p> <ul style="list-style-type: none"> • Toxicants in water: refer to AWQG section 3.4—‘water quality guidelines for toxicants’ (including tables 3.4.1, 3.4.2, and Figure 3.4.1), and AWQG volume 2 (section 8). Values correspond to protection of 99% species • Aluminium: <2.1 µg/L (Source: Golding, LA, Angel, BM, Batley, GE, Apte, SC, Krassoi, R and Doyle, CJ (2014) Derivation of a water quality guideline for aluminium in marine waters, <i>Environ Toxicol Chem.</i>, Accepted Article DOI: 10.1002/etc.2771, accepted 3 October 2014 • Toxicants in sediments: refer to AWQG section 3.5—‘sediment quality guidelines’ (including Table 3.5.1, Figure 3.5.1), and AWQG volume 2 (section 8) <p>Sewage: Release of sewage from vessels to be controlled in accordance with requirements of the Transport Operations (Marine Pollution) Act 1995 and Regulations. (Refer to Maritime Services Queensland website for further information.)</p> <p>Anti-fouling: Comply with <i>Anti-fouling and in-water cleaning guidelines</i> (June 2013)</p>														
Coastal waters in ports, marinas, spoil grounds: toxicants (s3, s5)	all	<p>Pesticides:</p> <p>WQOs for all pesticides in these waters as per GBRMPA and AWQG water quality guidelines, to protect marine species at the HEV level of protection (except where noted).</p> <p>Pesticides/biocides specified in GBR water quality guidelines include:</p> <ul style="list-style-type: none"> • Ametryn: <0.5 µg/L; Atrazine: <0.6 µg/L; Diuron: <0.9 µg/L; Hexazinone: <1.2 µg/L; Simazine: <0.2 µg/L; Tebuthiuron: <0.02 µg/L; 2,4-D: <0.8 µg/L ; Tributyltin: <0.006 µg/L (95% species protection) <p>For other toxicants not listed in GBRMPA guidelines, refer to AWQG and sources below::</p> <ul style="list-style-type: none"> • Toxicants in water: refer to AWQG volume 1 section 3.4—‘water quality guidelines for toxicants’ (including tables 3.4.1, 3.4.2, and Figure 3.4.1), and AWQG volume 2 (section 8). AWQG values for the MD level of protection typically correspond to protection of 95% species (in a small number of cases where bioaccumulation may occur, the AWQG recommends 99% species protection level). • Aluminium: <24 µg/L (Source: Golding, LA, Angel, BM, Batley, GE, Apte, SC, Krassoi, R and Doyle, CJ (2014) Derivation of a water quality guideline for aluminium in marine waters, <i>Environ Toxicol Chem.</i>, Accepted Article DOI: 10.1002/etc.2771, accepted 3 October 2014 • Toxicants in sediments: refer to AWQG volume 1 section 3.5—‘sediment quality guidelines’ (including Table 3.5.1, Figure 3.5.1), and AWQG volume 2 (section 8) <p>Sewage: Release of sewage from vessels to be controlled in accordance with requirements of the Transport Operations (Marine Pollution) Act 1995 and Regulations. (Refer to Maritime Services Queensland website for further information.)</p> <p>Anti-fouling: Comply with <i>Anti-fouling and in-water cleaning guidelines</i> (June 2013).</p>														

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	SHOALWATER COASTAL WATERS: Water quality objectives (WQOs) ^{1–7}														
		<p>Note: WQOs for indicators are shown as 20th, 50th and 80th percentiles (e.g. 3–4–5), lower and upper limits (20th/80th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80th percentile) (e.g. <15).</p> <p>HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed</p>														
		Amm N (µg/L)	Oxid N (µg/L)	Partic N (µg/L)	Total Diss N (µg/L)	Total N (µg/L)	FRP (µg/L)	Partic P (µg/L)	Total Diss P (µg/L)	Total P (µg/L)	Chl-a (µg/L)	Silicate (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)
Estuaries: biological	all	<p><u>Seagrass:</u> Minimum light requirement is a photosynthetic active radiation (PAR) two week moving average of greater than 6 mol m⁻² day⁻¹. This is minimum requirement only and is generally below the current average conditions of the harbour. It does not include potential impacts on benthic microalgae and phytoplankton at this light level. Objective based on Chartrand et al. (2012) <i>Development of a Light-Based Seagrass Management Approach for the Gladstone Western Basin Dredging Program</i>.</p> <p><u>Mangroves:</u> No loss of mangrove area. EHP/ Queensland Herbarium conducts biennial mapping of mangrove cover and this could be used as an assessment tool. Mapping is available from EHP.</p>														

Sources: S1: Local datasets (e.g. DSITIA, key stakeholder); S2: QWQG guidelines and /or data; S3: GBRMPA (2010) WQG; S4: GBRMPA analysis of Reef Rescue Marine Monitoring Program and/or Long Term Monitoring Program datasets; S5: ANZECC (2000) AWQG

Notes 1–7: Refer notes after Table 2C.

AQUATIC ECOSYSTEM EV

WATER QUALITY OBJECTIVES FOR WATER PARK CREEK BASIN AND ADJACENT COASTAL WATERS

Table 2C Water Park Creek Basin and adjacent coastal waters: Water quality objectives to protect aquatic ecosystem environmental value under baseflow conditions

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	WATER PARK CREEK: Baseflow water quality objectives (WQOs) ¹⁻⁷											
		Note: WQOs for indicators are shown as 20 th , 50 th and 80 th percentiles (e.g. 3–4–5), lower and upper limits (20 th /80 th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80 th percentile) (e.g. <15).											
		HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed											
		Amm N (µg/L)	Oxid N (µg/L)	Total N (µg/L)	FRP (µg/L)	Total P (µg/L)	Chl-a (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)	EC (µS/cm)	pH
WATER PARK CREEK FRESH WATERS													
HEV2404 (Shoalwater Bay Defence eastern, southern creeks) (s1)	HEV	<20 (DO>80%) <30 (DO 40–80%) <60 (DO<40%)	2–2–5	180–350–620	2–2–3	14–20–28	0.5–1–4	Refer Amm N	6–17–30	-	-	150–200–270	5.5–7
Shoalwater Bay Defence sand aquifer creeks (in HEV2404) (s1)	HEV	6–12–17	40–58–76	260–360–400	2–2–2	3–9–10	<0.5–<0.5–<0.5	85–90–95	2–3–4	-	-	130–135–160	4–5
HEV2405, 2406, 2421, 2422 (national park) (s1)	HEV	Insufficient data. Refer to QWQG for details on how to establish local WQOs. Review applicability of Shoalwater Bay fresh water WQOs (above rows) for HEV2405 depending on local water type.											
HEV fresh waters: toxicants (s5)	HEV	Toxicants in water and sediment as per AWQG: <ul style="list-style-type: none"> Toxicants in water: refer to AWQG volume 1 section 3.4—‘water quality guidelines for toxicants’ (including tables 3.4.1, 3.4.2, and Figure 3.4.1), and AWQG volume 2 (section 8). AWQG values for the HEV level of protection correspond to protection of 99% species Toxicants in sediments: refer to AWQG volume 1 section 3.5—‘sediment quality guidelines’ (including Table 3.5.1, Figure 3.5.1), and AWQG volume 2 (section 8) Anti-fouling: Comply with <i>Anti-fouling and in-water cleaning guidelines</i> (June 2013)											
Upland fresh >150m (s2)	MD	<10	<15	<250	<15	<30	na	90–110	<25	-	id	-	6.5–7.5

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	WATER PARK CREEK: Baseflow water quality objectives (WQOs) ¹⁻⁷											
		Note: WQOs for indicators are shown as 20 th , 50 th and 80 th percentiles (e.g. 3–4–5), lower and upper limits (20 th /80 th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80 th percentile) (e.g. <15). HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed											
		Amm N (µg/L)	Oxid N (µg/L)	Total N (µg/L)	FRP (µg/L)	Total P (µg/L)	Chl-a (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)	EC (µS/cm)	pH
Waterpark Creek lowland fresh <150m (s1)	MD	<25	<35	<520	<2	<17	<3	60–70	<6	-	-	-	5.4–6.5
Lowland fresh <150m (all other) (s2)	MD	<20	<60	<500	<20	<50	<5	85–110	<50	-	<10	-	6.5–8.0
Lakes / reservoirs (s2)	MD	<10	<10	<350	<5	<10	<5	90–110	1–20	-	id	-	6.5–8.0
Fresh waters: macro- invertebrates (s1)	all	<ul style="list-style-type: none"> • Taxa richness: 15–27 (taxa richness is the number of aquatic macroinvertebrates collected in a sample) • Average SIGNAL grade: 3.88–4.69 (SIGNAL: stream invertebrate grade number – average level; version 2.iv) • % tolerant taxa: 15.79–33.33% (tolerant taxa is based on the proportion of taxa with 'tolerant' sensitivity grades (SIGNAL grades 1,2, 3)) 											
Fresh waters: toxicants (s5)	MD	Toxicants: Toxicants in water and sediment as per AWQG: <ul style="list-style-type: none"> • Toxicants in water: refer to AWQG volume 1 section 3.4—'water quality guidelines for toxicants' (including tables 3.4.1, 3.4.2, and Figure 3.4.1), and AWQG volume 2 (section 8). AWQG values for the MD level of protection typically correspond to protection of 95% species (in a small number of cases where bioaccumulation may occur, the AWQG recommends 99% species protection level). • Toxicants in sediments: refer to AWQG volume 1 section 3.5—'sediment quality guidelines' (including Table 3.5.1, Figure 3.5.1), and AWQG volume 2 (section 8) Anti-fouling: Comply with <i>Anti-fouling and in-water cleaning guidelines</i> (June 2013)											
Fresh waters: ionic indicators	all	Refer to additional ionic indicators in Table 14 (from DSITIA analyses) where not included above											
WETLANDS (s5)	all	id	id	id	id	id	id	id	id	-	id	-	id
RIPARIAN	all	Refer to section 3.1.2											
GROUND WATERS (s1)	HEV	WQOs are provided according to their chemistry zone and depth category in Table 14 (refer plan WQ1273). Where groundwaters interact with surface waters, groundwater quality should not compromise identified EVs and WQOs for those waters. Note: the AWQG recommends that the highest level of protection should be provided to underground aquatic ecosystems, given their high conservation value. Where groundwaters are in good condition the intent is to maintain existing water quality (20th, 50th and 80th percentiles).											

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	WATER PARK CREEK: Baseflow water quality objectives (WQOs) ¹⁻⁷											
		Note: WQOs for indicators are shown as 20 th , 50 th and 80 th percentiles (e.g. 3–4–5), lower and upper limits (20 th /80 th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80 th percentile) (e.g. <15).											
		HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed											
		Amm N (µg/L)	Oxid N (µg/L)	Total N (µg/L)	FRP (µg/L)	Total P (µg/L)	Chl-a (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)	EC (µS/cm)	pH
WATER PARK CREEK ESTUARINE WATERS													
HEV2404 Middle estuary in Shoalwater Bay Defence (s2)	HEV	3–6–10	2–3–10	130–200–300	3–5–8	12–16–25	1.5–2.5–4.0	85–90–100	id	id	id	-	7.0–8.4
HEV2405 (Middle estuary in national park)	Refer WQOs for Waterpark Creek estuary (below)												
SD2426 Cawarral and Coorooman Creek middle estuary (s2)	HEV	3–6–10	2–3–10	130–200–300	3–5–8	12–16–25	1.5–2.5–4.0	85–90–100	3–5–8	1.0–1.4–2.0	8–15–20	-	7.0–8.4
SD2426 Cawarral and Coorooman Creek lower estuary (s2)	HEV	2–3–8	2–2–3	100–130–200	2–2–6	6–9–20	0.5–1.0–2.0	90–95–100	1–3–6	1.5–2.3–3.1	6–12–15	-	8.0–8.4
SD2423 Waterpark Creek estuary (14-22km AMTD) (s1)	HEV	25–35–50	30–45–60	400–480–600	4–5–6	33–37–50	4.5–7–13	75–85	18–25–40	0.4–0.5–0.6	-	-	6.8–7.5
SD2423 Waterpark Creek estuary (6-14km AMTD) (s1)	HEV	2–4–15	2–8–20	150–190–260	2–3–4	15–15–20	2–2.6–3.5	80–100	8–10–14	1.0–1.2–1.4	-	-	7.5–7.9
SD2423 Waterpark Creek estuary (0-6km AMTD), including Corio Bay (s1)	HEV	2–2–4	2–2–4	120–150–200	2–2–4	10–11–16	1–1.3–2	95–105	3–7–10	1.2–1.6–2.3	-	-	7.5–8.1

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	WATER PARK CREEK: Baseflow water quality objectives (WQOs) ¹⁻⁷											
		<p>Note: WQOs for indicators are shown as 20th, 50th and 80th percentiles (e.g. 3–4–5), lower and upper limits (20th/80th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80th percentile) (e.g. <15).</p> <p>HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed</p>											
		Amm N (µg/L)	Oxid N (µg/L)	Total N (µg/L)	FRP (µg/L)	Total P (µg/L)	Chl-a (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)	EC (µS/cm)	pH
Causeway Lake and adjacent estuary (s1)	MD	<12	<7	<360	<3	<27	<2	90–120	<9	-	<10	-	8.0–8.4
Middle estuary (all others) (s2)	MD	<10	<10	<300	<8	<25	<4	85–100	<8	>1	<20	-	7.0–8.4
Estuaries	all	<p>Toxicants in water and sediment as per AWQG:</p> <ul style="list-style-type: none"> Toxicants in water: refer to AWQG volume 1 section 3.4—'water quality guidelines for toxicants' (including tables 3.4.1, 3.4.2, and Figure 3.4.1), and AWQG volume 2 (section 8, including section 8.3.4.4 on application in estuarine waters) Toxicants in sediments: refer to AWQG volume 1 section 3.5—'sediment quality guidelines' (including Table 3.5.1, Figure 3.5.1), and AWQG volume 2 (section 8) <p>Sewage: Release of sewage from vessels to be controlled in accordance with requirements of the Transport Operations (Marine Pollution) Act 1995 and Regulations. (Refer to Maritime Services Queensland website for further information.)</p> <p>Anti-fouling: Comply with <i>Anti-fouling and in-water cleaning guidelines</i> (June 2013)</p>											
Estuaries: biological	all	<p><u>Seagrass</u>: Minimum light requirement is a photosynthetic active radiation (PAR) two week moving average of greater than 6 mol m⁻² day⁻¹. This is minimum requirement only and is generally below the current average conditions of the harbour. It does not include potential impacts on benthic microalgae and phytoplankton at this light level. Objective based on Chartrand et al. (2012) <i>Development of a Light-Based Seagrass Management Approach for the Gladstone Western Basin Dredging Program</i>.</p> <p><u>Mangroves</u>: No loss of mangrove area. EHP/ Queensland Herbarium conducts biennial mapping of mangrove cover and this could be used as an assessment tool. Mapping is available from EHP.</p>											

Sources: S1: Local datasets (e.g. DSITIA, key stakeholder); S2: QWQG guidelines and /or data; S3: GBRMPA (2010) WQG; S4: GBRMPA analysis of Reef Rescue Marine Monitoring Program and/or Long Term Monitoring Program datasets; S5: ANZECC (2000) AWQG

Notes 1–7: Refer notes after Table 2C.

Table 2C continued

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	WATER PARK CREEK COASTAL WATERS: Water quality objectives (WQOs) ¹⁻⁷															
		Note: WQOs for indicators are shown as 20 th , 50 th and 80 th percentiles (e.g. 3–4–5), lower and upper limits (20 th /80 th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80 th percentile) (e.g. <15).															
		HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed															
		Amm N (µg/L)	Oxid N (µg/L)	Partic N (µg/L)	Total Diss N (µg/L)	Total N (µg/L)	FRP (µg/L)	Partic P (µg/L)	Total Diss P (µg/L)	Total P (µg/L)	Chl-a (µg/L)	Silicate (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)	pH
WATER PARK CREEK COASTAL and MARINE WATERS																	
HEV2426 LE/EC waters, in / adjacent to Shoalwater Bay (s2)	HEV	2–3–8	2–2–3	-	-	100–130–200	2–2–6	-	-	6–9–20	0.5–1.0–2.0	-	90–95– 100	id	id	id	8.0–8.4
Keppel Bay LE/EC waters (incl Rosslyn Bay marina, boat harbour) (s2)	MD	<8	<3	-	-	<200	<6	-	-	<20	<2	-	90–100	id	id	id	8.0–8.4
HEV2424 Marine waters north-east of Shoalwater Bay (seaward of GBR plume line) (s4, s3, s2)	HEV	1–2–6	0–0–1	14–18–25	45–75–105	60–90–130	1–2–4	1.6–2.1–3.0	4–9–17	6–12–20	≤0.45 (ann. mean)	40–60– 100	95–105	-	≥10	1.1–1.6– 2.4	8.1–8.3– 8.4
HEV2425 Open coastal macro-tidal waters in Shoalwater Bay (seaward of GBR plume line)	HEV	1–2–6	0–0–1	≤20 (ann. mean)	45–75–105	60–90–130	1–2–4	≤2.8 (ann. mean)	4–9–17	6–12–20	≤0.45 (ann. mean)	40–60– 100	95–105	id	≥8	≤2.4 (ann. mean)	8.1–8.3– 8.4

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	WATER PARK CREEK COASTAL WATERS: Water quality objectives (WQOs) ¹⁻⁷															
		Note: WQOs for indicators are shown as 20 th , 50 th and 80 th percentiles (e.g. 3–4–5), lower and upper limits (20 th /80 th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80 th percentile) (e.g. <15).															
		HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed															
		Amm N (µg/L)	Oxid N (µg/L)	Partic N (µg/L)	Total Diss N (µg/L)	Total N (µg/L)	FRP (µg/L)	Partic P (µg/L)	Total Diss P (µg/L)	Total P (µg/L)	Chl-a (µg/L)	Silicate (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)	pH
(s4, s3, s2)																	
HEV2427 Open coastal waters south of Cape Clinton (seaward of GBR plume line) (s4, s3, s2)	HEV	0–1–3	0–0–1	12–15–20	60–70–100	75–85–120	1–2–3	1.5–2.5–3	5–6–10	6–10–15	≤0.45 (ann. mean)	40–60– 125	95–105	0.3–0.5– 1.5	7–10–11	0.4–1.0– 1.9	8.1–8.3– 8.4
HEV2428 Midshelf waters to State limits (seaward of GBR plume line) (s4, s3, s2)	HEV	1–2–3	0–1–2	10–12–18	60–80–95	75–95–110	2–2–3	1.5–1.9–2.7	5–6–12	8–10–15	0.18–0.27– 0.42	30–45– 75	95–105	0.2–0.3– 0.5	9–12–15	0.2–0.4– 1.2	8.1–8.3– 8.4
HEV2429 Swain Reefs (seaward of GBR plume line) (s4, s3, s2)	HEV	0–1–3	0–0–1	10–13–16	50–65–80	80–90–110	0–1–3	1.1–1.7–2.2	3–6–10	5–8–15	0.24–0.32– 0.47	15–35– 125	95–105	≤0.5	≥19 (ann. mean)	0.2–0.4– 0.9	8.1–8.3– 8.4

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	WATER PARK CREEK COASTAL WATERS: Water quality objectives (WQOs) ¹⁻⁷															
		Note: WQOs for indicators are shown as 20 th , 50 th and 80 th percentiles (e.g. 3–4–5), lower and upper limits (20 th /80 th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80 th percentile) (e.g. <15). HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed															
		Amm N (µg/L)	Oxid N (µg/L)	Partic N (µg/L)	Total Diss N (µg/L)	Total N (µg/L)	FRP (µg/L)	Partic P (µg/L)	Total Diss P (µg/L)	Total P (µg/L)	Chl-a (µg/L)	Silicate (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)	pH
SD2424, 2425 Keppel Bay open coastal waters in Marine Park protection zone (landward of GBR plume line) (s4, s3, s2)	HEV	0–1–3	0–0–1	≤20 (ann. mean)	60–70–100	75–85–120	1–2–3	≤2.8 (ann. mean)	5–6–10	6–10–15	≤0.45 (ann. mean)	40–60– 125	95–105	≤1.5 (ann. mean)	≥10	≤2.0 (ann. mean)	8.1–8.4
Keppel Bay open coastal waters (landward of GBR plume line) (all OC waters that are not identified as SD or HEV) (s4, s3, s2)	SMD	<1	<0.5	≤20 (ann. mean)	<70	<85	<2	≤2.8 (ann. mean)	<6	<10	≤0.45 (ann. mean)	>60	95–105	≤1.5 (ann. mean)	≥10	≤2.0 (ann. mean)	8.1–8.4
Coastal and marine waters (s3)	all	Temperature: increases of no more than 1°C above long-term (20 year) average maximum. (GBRMPA, 2010)															
Coastal waters outside ports, marinas, spoil grounds: toxicants (s3, s5)	all	WQOs for all toxicants in these waters as per GBRMPA and AWQG water quality guidelines, to protect marine species at the HEV level of protection. Pesticides/biocides specified in GBR water quality guidelines include: <ul style="list-style-type: none"> • Ametryn: <0.5 µg/L; Atrazine: <0.6 µg/L; Diuron: <0.9 µg/L; Hexazinone: <1.2 µg/L; Simazine: <0.2 µg/L; Tebuthiuron: <0.02 µg/L; 2,4-D: <0.8 µg/L; Tributyltin: <0.0004 µg/L For other toxicants not listed in GBRMPA guidelines, refer to AWQG and sources below: <ul style="list-style-type: none"> • Toxicants in water: refer to AWQG section 3.4—'water quality guidelines for toxicants' (including tables 3.4.1, 3.4.2, and Figure 3.4.1), and AWQG volume 2 (section 8). Values correspond to protection of 99% species • Aluminium: <2.1 µg/L (Source: Golding, LA, Angel, BM, Batley, GE, Apte, SC, Krasso, R and Doyle, CJ (2014) Derivation of a water quality guideline for aluminium in marine waters, <i>Environ Toxicol Chem.</i>, Accepted Article • DOI: 10.1002/etc.2771, accepted 3 October 2014 • Toxicants in sediments: refer to AWQG section 3.5—'sediment quality guidelines' (including Table 3.5.1, Figure 3.5.1), and AWQG volume 2 (section 8) Sewage: Release of sewage from vessels to be controlled in accordance with requirements of the Transport Operations (Marine Pollution) Act 1995 and Regulations. (Refer to Maritime															

Water area/type Refer plans WQ1271, 1272, 1273 (s1–s5: source for WQOs, listed after table)	Management intent /level of protection	WATER PARK CREEK COASTAL WATERS: Water quality objectives (WQOs) ¹⁻⁷														
		<p>Note: WQOs for indicators are shown as 20th, 50th and 80th percentiles (e.g. 3–4–5), lower and upper limits (20th/80th percentiles, e.g. pH: 7.2-8.2), or as a single values (median or 80th percentile) (e.g. <15).</p> <p>HEV: high ecological value; SD: slightly disturbed; MD: moderately disturbed</p>														
		Amm N (µg/L)	Oxid N (µg/L)	Partic N (µg/L)	Total Diss N (µg/L)	Total N (µg/L)	FRP (µg/L)	Partic P (µg/L)	Total Diss P (µg/L)	Total P (µg/L)	Chl-a (µg/L)	Silicate (µg/L)	DO (% sat)	Turb (NTU)	Secchi (m)	SS (mg/L)
		<p>Services Queensland website for further information.) Anti-fouling: Comply with <i>Anti-fouling and in-water cleaning guidelines</i> (June 2013)</p>														
Coastal waters in ports, marinas, spoil grounds: toxicants (s3, s5)	all	<p>Pesticides: WQOs for all pesticides in these waters as per GBRMPA and AWQG water quality guidelines, to protect marine species at the HEV level of protection (except where noted). Pesticides/biocides specified in GBR water quality guidelines include:</p> <ul style="list-style-type: none"> • Ametryn: <0.5 µg/L; Atrazine: <0.6 µg/L; Diuron: <0.9 µg/L; Hexazinone: <1.2 µg/L; Simazine: <0.2 µg/L; Tebuthiuron: <0.02 µg/L; 2,4-D: <0.8 µg/L ; Tributyltin: <0.006 µg/L (95% species protection) <p>For other toxicants not listed in GBRMPA guidelines, refer to AWQG and sources below:</p> <ul style="list-style-type: none"> • Toxicants in water: refer to AWQG volume 1 section 3.4—'water quality guidelines for toxicants' (including tables 3.4.1, 3.4.2, and Figure 3.4.1), and AWQG volume 2 (section 8). AWQG values for the MD level of protection typically correspond to protection of 95% species (in a small number of cases where bioaccumulation may occur, the AWQG recommends 99% species protection level). • Aluminium: <24 µg/L (Source: Golding, LA, Angel, BM, Batley, GE, Apte, SC, Krassoi, R and Doyle, CJ (2014) Derivation of a water quality guideline for aluminium in marine waters, <i>Environ Toxicol Chem.</i>, Accepted Article • DOI: 10.1002/etc.2771, accepted 3 October 2014 • Toxicants in sediments: refer to AWQG volume 1 section 3.5—'sediment quality guidelines' (including Table 3.5.1, Figure 3.5.1), and AWQG volume 2 (section 8) <p>Sewage: Release of sewage from vessels to be controlled in accordance with requirements of the Transport Operations (Marine Pollution) Act 1995 and Regulations. (Refer to Maritime Services Queensland website for further information.) Anti-fouling: Comply with <i>Anti-fouling and in-water cleaning guidelines</i> (June 2013)</p>														
Estuaries: biological	all	<p>Seagrass: Minimum light requirement is a photosynthetic active radiation (PAR) two week moving average of greater than 6 mol m⁻² day⁻¹. This is minimum requirement only and is generally below the current average conditions of the harbour. It does not include potential impacts on benthic microalgae and phytoplankton at this light level. Objective based on Chartrand et al. (2012) <i>Development of a Light-Based Seagrass Management Approach for the Gladstone Western Basin Dredging Program</i>.</p> <p>Mangroves: No loss of mangrove area. EHP/ Queensland Herbarium conducts biennial mapping of mangrove cover and this could be used as an assessment tool. Mapping is available from EHP.</p>														

Sources: S1: Local datasets (e.g. DSITIA, key stakeholder); S2: QWQG guidelines and/or data; S3: GBRMPA (2010) WQG; S4: GBRMPA analysis of Reef Rescue Marine Monitoring Program and/or Long Term Monitoring Program datasets; S5: ANZECC (2000) AWQG

Notes to Table 2 (where applicable):

Abbreviations: id: insufficient information; na: not applicable; -: WQO for indicator not available. Will be updated if guidelines become available

1. Nutrients: Except where specified for event conditions, nutrient objectives 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. Provided that levels of inorganic N (i.e. NH₃ + oxidised N) remain low, then the elevated levels of organic N should not be seen as a breach 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. Suspended solids: Suspended solids (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.
3. Oxidised N = NO₂ + NO₃
4. Dissolved oxygen (DO): Dissolved Oxygen (DO) objectives 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 fresh waters, 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 fresh waters, 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 for fresh waters should only be applied to flowing waters. Stagnant pools in intermittent streams naturally experience values of DO below 50 per cent saturation.
5. Wallum habitat: Wallum/tannin-stained waters contain naturally high levels of humic acids (and have a characteristic brown tea-tree stain). In these types of waters, natural pH values may range from 3.6 to 6. During flood events or nil flow periods, pH values should not fall below 5.5 (except in wallum/tannin waters) or exceed 9.
6. Temperature: Temperature varies both daily and seasonally, it is depth dependent and is also highly site specific. It is therefore not possible to provide simple generic WQOs for this indicator for fresh or estuarine waters. (In open coastal/marine waters a WQO based on GBRMPA WQGs is provided.) The recommended approach is that local WQOs be developed. Thus, WQOs for potentially impacted streams should be based on measurements from nearby streams that have similar morphology and which are thought not to be impacted by anthropogenic thermal influences. From an ecological effects perspective, the most important aspects of temperature are the daily maximum temperature and the daily variation in temperature. Therefore measurements of temperature should be designed to collect information on these indicators of temperature and, similarly, local WQOs should be expressed in terms of these indicators. There will be an annual cycle in the values of these indicators and therefore a full seasonal cycle of measurements is required to develop guideline values.
7. Open coastal/marine waters – GBR plume line: The GBR plume discharge area is derived from a smoothed version of the 'high' and 'very high' risk classes of modelled outputs from the risk assessment element of the Reef Plan Scientific Consensus Statement 2013 (Waterhouse et al 2013). The high risk area indicated for Shoalwater Bay in that output is excluded based on local data on the condition of the Shoalwater catchment (small flow, naturally vegetated, good water quality condition), and the natural influence of the high tidal regime on the re-suspension of sediments (likely causing high reflectance in remote sensing analysis) (DSITIA 2012, DSITIA 2014).

References:

- ANZECC & ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality (AWQG).
- Australian Government (2013) *Anti-fouling and in-water cleaning guidelines* (June 2013), Department of Agriculture, Fisheries and Forestry, Canberra.
- De'ath G, Fabricius KE (2008) Water quality of the Great Barrier Reef: distributions, effects on reef biota and trigger values for the protection of ecosystem health. Final Report to the Great Barrier Reef Marine Park Authority. Australian Institute of Marine Science, Townsville. (104 pp.).
- Department of Science, Information Technology, Innovation and the Arts, Queensland (2014) Report on draft aquatic ecosystem water quality guidelines for the Capricorn Curtis Coast (draft).
- DSITIA (2012). Report on the 2012 Water Quality Monitoring Program in the Shoalwater Bay Training Area.
- Golding, LA, Angel, BM, Batley, GE, Apte, SC, Krassoi, R and Doyle, CJ (2014) Derivation of a water quality guideline for aluminium in marine waters, *Environ Toxicol Chem.*, Accepted Article • DOI: 10.1002/etc.2771, accepted 3 October 2014.
- Great Barrier Reef Marine Park Authority (2010) Water quality guidelines for the Great Barrier Reef Marine Park 2010, Great Barrier Reef Marine Park Authority, Townsville, available on the Great Barrier Reef Marine Park Authority's website.
- Negus P, Stewart, A, and Blessing J (2014) Queensland interim macroinvertebrate guidelines: Capricorn Coast and Curtis Coast Basins. Report by Water Planning Ecology for the Department of Environment and Heritage Protection. February 2014 – draft.
- Queensland Government (2009, as amended) Queensland Water Quality Guidelines. (Refer to section 5 and Appendix D of the QWQG for more detail on compliance assessment protocols.)

Schaffelke B, Carleton J, Doyle J, Furnas M, Gunn K, Skuza M, Wright M, Zagorskis I (2011) Reef Rescue Marine Monitoring Program. Final Report of AIMS Activities 2010/11– Inshore Water Quality Monitoring. Report for the Great Barrier Reef Marine Park Authority. Australian Institute of Marine Science, Townsville. (83 p.). Additional years also published accessible for download from GBRMPA.

Transport Operations (Marine Pollution) Act 1995 and Regulations 2008, available on the Office of Queensland Parliamentary Counsel website.

Waterhouse, J., Maynard, J., Brodie, J., Randall, L., Zeh, D., Devlin, M., Lewis, S., Furnas, M., Schaffelke, B., Fabricius, K., Collier, C., Brando, V., McKenzie, L., Warne, M.St.J., Smith, R., Negri, A., Henry, N., Petus, C., da Silva, E., Waters, D., Yorkston, H., Tracey, D., 2013. *Section 2: Assessment of the risk of pollutants to ecosystems of the Great Barrier Reef including differential risk between sediments, nutrients and pesticides, and among NRM regions.* In: Brodie *et al.*, *Assessment of the relative risk of water quality to ecosystems of the Great Barrier Reef. A report to the Department of the Environment and Heritage Protection, Queensland Government, Brisbane.* TropWATER Report 13/28, Townsville, Australia.

3.1.2 Vegetation (riparian, wetlands) objectives

The clearing of native vegetation in Queensland is regulated by the *Vegetation Management Act 1999*, the *Sustainable Planning Act 2009* and associated policies and codes. This includes the regulation of clearing in water and drainage lines.

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

- State Development Assessment Provisions (SDAP) Module 8: Native vegetation clearing. This module includes performance requirements relating to clearing of native vegetation and a table relating to watercourse buffer areas and stream order. To review the SDAP Modules, refer to the Department of State Development, Infrastructure and Planning website
- SDAP Module 11: Wetland protection area
- relevant self-assessable codes under the *Vegetation Management Act 1999*. These codes are activity based, some applying to different regions, and include performance requirements relating to watercourses and wetlands, aimed at maintaining water quality, bank stability, aquatic and terrestrial habitat. Codes include vegetation clearing controls that vary according to stream order. To review the latest applicable self-assessable code (and other explanatory information), refer to the Department of Natural Resources and Mines website

To review the current vegetation management laws refer to the Queensland Government website or Department of Natural Resources and Mines website.

To review the SDAP Modules, refer to the Department of State Development, Infrastructure and Planning website.

Local Government Planning schemes under the *Sustainable Planning Act 2009* may also specify riparian buffers (for example under catchment protection or waterway codes). Refer to the Department of State Development, Infrastructure and Planning website and local government websites for further information about planning schemes.

Wetlands

The Environmental Protection Regulation section 81A defines environmental values for wetlands.

The State assesses impacts from earth works that may have impacts on freshwater wetlands of High Ecological Significance in Great Barrier Reef Catchments against State Development Assessment Provisions (SDAP) Module 11: Wetland protection area.

This module includes performance requirements to ensure:

- adverse effects on hydrology, water quality and ecological processes of a wetland are avoided or minimised
- any significant adverse impacts on matters of state environmental significance and on riparian areas or wildlife corridors in strategic environmental areas are avoided.

3.1.3 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 *Sustainable Planning Act 2009*.)

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 planning schemes, acid sulfate soils and water supply buffer areas.

The provisions of the SPP are operationalised through the SPP code – water quality (Appendix 3 of the SPP). The purpose of the code is to ‘ensure development is planned, designed, constructed and operated to manage stormwater and wastewater in ways that support the protection of environmental values identified in the Environmental Protection (Water) Policy 2009’. The code contains detailed performance objectives for planning schemes, development and land use activities to implement the code’s purpose. These include stormwater management design objectives by climatic region (construction and post-construction phases).

The SPP (state interest – water quality) is supported by the State Planning Policy—state interest guideline – water quality. The SPP (including SPP code) and supporting guideline are available from the DSDIP website.

WATER QUALITY OBJECTIVES
for
HUMAN USE ENVIRONMENTAL VALUES

3.2 Water quality objectives for human use environmental values

This section outlines WQOs to protect human use EVs, which comprise those EVs other than the aquatic ecosystem EV (e.g. recreation, stock watering, aquaculture and crop irrigation). Table 1 of this document outlines the EVs that have been identified for different waters in the catchment. Where a human use EV has been identified, the following tables can be used to identify the WQOs to support that EV. Where table 1 indicates 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.

WQOs in this section are, unless otherwise specified, based on relevant national water quality guidelines including AWQG and the ADWG⁶. Table 3 outlines human use EVs, applicable water types, and a selection of more commonly used WQOs to support those EVs. Tables 4 to 12 provide further WQOs to protect particular human use EVs (based on national guidelines or other more local studies). 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.

Table 3 Water quality objectives to protect human use environmental values

Environmental value	Water type/area (refer Table 1 and plans WQ1271, 1272, 1273)	Water quality objectives to protect EV (refer to specified codes and guidelines for full details)
Suitability for drinking water supply	All fresh waters including groundwaters	Local WQOs for drinking water supply are provided in Table 4. Note: For water quality after treatment or at point of use refer to legislation and guidelines, including: <ul style="list-style-type: none"> • <i>Public Health Act 2005</i> and Regulation • <i>Water Supply (Safety and Reliability) Act 2008</i>, including any approved drinking water quality management plan under the Act • <i>Water Fluoridation Act 2008</i> and Regulation • <i>Australian Drinking Water Guidelines (ADWG) 2011</i>, as amended.
Protection of the human consumer for oystering	Estuarine and coastal waters	Objectives as per AWQG and Australia New Zealand Food Standards Code ⁷ , Food Standards Australia New Zealand, as amended.
Protection of the human consumer	Fresh waters, estuarine and coastal waters	Objectives as per AWQG 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	No WQOs are provided in this scheduling document for industrial uses. Water quality requirements for industry vary within and between industries. The AWQG do not provide guidelines to protect industries, and indicate that industrial water

⁶ The AWQG are available on the National Water Quality Management Strategy website.

The ADWG are available on the NHMRC website.

⁷ Information on the Australia New Zealand Food Standards Code is available on the Food Standards Australia and New Zealand website.

Environmental value	Water type/area (refer Table 1 and plans WQ1271, 1272, 1273)	Water quality objectives to protect EV (refer to specified codes and guidelines for full details)
		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	Objectives as per: <ul style="list-style-type: none"> • tables 5–7 • AWQG and Australia New Zealand Food Standards Code, Food Standards Australia New Zealand, 2007 and updates.
Suitability for irrigation	All fresh waters including groundwaters	ANZECC objectives for pathogens and metals are provided in tables 8 and 9. For other indicators, such as salinity, sodicity and herbicides, see AWQG.
Suitability for stock watering	All fresh waters including groundwaters	Objectives as per AWQG, including median faecal coliforms <100 organisms per 100 mL. WQOs for total dissolved solids and metals are provided in Tables 10 and 11, based on AWQG. For other objectives, such as cyanobacteria and pathogens, see AWQG.
Suitability for farm supply/use	All fresh waters including groundwaters	Objectives as per AWQG.
Suitability for primary contact recreation	Fresh waters, estuarine and coastal waters	Objectives as per NHMRC (2008) ⁸ , including: <ul style="list-style-type: none"> • water free of physical (floating and submerged) hazards • temperature range: 16–34°C • pH range: 6.5–8.5 • DO: >80% • 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: <ul style="list-style-type: none"> – assessment of evidence for the likely influence of faecal material – counts of suitable faecal indicator bacteria (usually <i>enterococci</i>) These two components are combined to produce an overall microbial classification of the recreational water body. • intestinal enterococci: 95th percentile ≤ 40 organisms per 100mL (for healthy adults) (NHMRC, 2008; table 5.7) • direct contact with venomous or dangerous aquatic organisms should be avoided. Recreational water bodies should be reasonably free of, or protected from, venomous organisms (e.g. box jellyfish and bluebottles) • waters contaminated with chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreational purposes.
Suitability for primary contact recreation	Fresh waters	<ul style="list-style-type: none"> • cyanobacteria/algae: Recreational water bodies should not contain: <ul style="list-style-type: none"> – level 1¹: ≥ 10 µg/L total microcystins; or ≥ 50 000 cells/mL toxic <i>Microcystis aeruginosa</i>; or biovolume equivalent of ≥ 4 mm³/L for the combined total of all cyanobacteria where a known toxin producer is dominant in the total biovolume or – level 2¹: ≥ 10 mm³/L for total biovolume of all cyanobacterial material where known toxins are not present or – cyanobacterial scums consistently present. Further details are contained in NHMRC (2008) and Table 12.

⁸ Guidelines for Managing Risks in Recreational Water are available on the NHMRC website.

Environmental value	Water type/area (refer Table 1 and plans WQ1271, 1272, 1273)	Water quality objectives to protect EV (refer to specified codes and guidelines for full details)
	Estuarine, coastal waters	<ul style="list-style-type: none"> • cyanobacteria/algae: Recreational water bodies should not contain ≥ 10 cells/mL <i>Karenia brevis</i> and/or have <i>Lyngbya majuscula</i> and/or <i>Pfiesteria</i> present in high numbers². Further details are contained in NHMRC (2008) and Table 12.
Suitability for secondary contact recreation	Fresh waters, estuarine and coastal waters	Objectives as per NHMRC (2008), including: <ul style="list-style-type: none"> • intestinal enterococci: 95th percentile ≤ 40 organisms per 100mL (for healthy adults) (NHMRC, 2008; table 5.7) • cyanobacteria/algae—refer objectives for primary recreation, NHMRC (2008) and table 12.
Suitability for visual recreation	Fresh waters, estuarine and coastal waters	Objectives as per NHMRC (2008), including: <ul style="list-style-type: none"> • 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. • cyanobacteria/algae—refer objectives for primary recreation, NHMRC (2008) and table 12.

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 documents, including:

Australian Drinking Water Guidelines (NHMRC, 2011 as updated 2013).

Australia New Zealand Food Standards Code (Australian Government: Food Standards Australia New Zealand).

Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000).

Guidelines for Managing Risks in Recreational Water (NHMRC, 2008).

Table 4 Drinking water EV: Priority water quality objectives for drinking water supply in the vicinity of off-takes, including groundwater, before treatment

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*, and the Australian Drinking Water Guidelines (ADWG, 2011 updated December 2013). Information sources are provided in and after the table.

Indicator	Water quality objective ¹
<i>Giardia</i>	0 cysts (Queensland Water Supply Regulator) No guideline value set (ADWG, 2011) If <i>Giardia</i> is detected in drinking water then the health authorities should be notified immediately and an investigation of the likely source of contamination undertaken (ADWG).
<i>Cryptosporidium</i>	0 cysts (Queensland Water Supply Regulator) No guideline value set (ADWG, 2011) If <i>Cryptosporidium</i> is detected in drinking water then the health authorities should be notified immediately and an investigation of the likely source of contamination undertaken (ADWG).
<i>E. coli</i>	Well designed treatment plants with effective barriers and disinfection are designed to address faecal contamination. <i>E. coli</i> or thermotolerant coliforms should not be present in any 100 mL sample of (treated) drinking water (ADWG).
Blue-green algae (cyanobacteria)	<100 cells/mL
Algal toxin	<1 µg/L Microcystin
pH	6.5–8.5 (ADWG 2011)
Total dissolved solids (TDS)	<600mg/L The concentration of total dissolved solids in treated drinking water should not exceed 600 mg/L (ADWG 2011, based on taste considerations).
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). At-risk groups (medical) ² : The concentration of sodium in water supplies for at-risk groups should not exceed 20 mg/L (ADWG).
Sulfate	The concentration of sulfate in drinking water should not exceed 250 mg/L (ADWG 2011, based on taste/aesthetic considerations). ADWG 2011 health guideline: <500mg/L
Dissolved oxygen	>85% saturation (ADWG, 2011)
Pesticides	Raw supplies: Below detectable limits. Treated drinking water: Refer to ADWG.
Other indicators (including physico-chemical indicators)	Refer to ADWG.

Notes:

1. All values are based on sources specified.
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).

Sources: Queensland Water Supply Regulator, Australian Drinking Water Guidelines (NHMRC, 2011, updated December 2013)

Table 5 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 °C	21–32	24–33	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 ppt	15–35 ppt	Lead	<0.03 mg/L
Hardness	20–450 mg/L		Manganese	<0.01 mg/L
Alkalinity	20–400 mg/L	>100mg/L	Mercury	<0.00005 mg/L
Turbidity	<80 NTU		Nickel	<0.01 mg/L in soft water <0.04 mg/L in hard water
Chlorine	<0.003 mg/L		Tin	<0.001 mg/L
Hydrogen sulphide	<0.002 mg/L		Zinc	0.03–0.06 mg/L in soft water 1–2 mg/L in hard water

Source: Department of Primary Industries and Fisheries: Water Quality in Aquaculture—DPI Notes April 2004.

Table 6 Aquaculture EV: Water quality objectives for optimal growth of particular species in fresh water

Water parameter	Barramundi	Eel	Silver perch	Jade perch	Sleepy cod	Redclaw
Dissolved oxygen	4–9 mg/L	>3 mg/L	>4 mg/L	>3 mg/L	>4.0 mg/L	>4.0 mg/L
Temperature °C	26–32	23–28	23–28	23–28	22–31	23–31
pH	7.5–8.5	7.0–8.5	6.5–9	6.5–9	7.0–8.5	7.0–8.5
Ammonia (TAN, Total ammonia-nitrogen)		<1.0 mg/L			<1.0 mg/L	<1.0 mg/L
Ammonia (NH ₃ , un-ionised form)*pH dependent.	<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)			<100 mg/L			
Nitrite (NO ₂)	<1.5 mg/L	<1.0 mg/L	<0.1 mg/L		<1.0 mg/L	<1.0 mg/L
Salinity (extended periods)	0–35 ppt		<5 ppt	<5 ppt		<4 ppt
Salinity bath	0–35 ppt		5–10 ppt for 1 hour		max. 20 ppt for one hour	
Hardness (CaCO ₃)			>50 mg/L	>50 mg/L	>40 mg/L	>40 mg/L
Alkalinity	>20 mg/L		100–400 ppm	100–400 ppm	>40 mg/L	>40 mg/L
Chlorine	<0.04 mg/L				<0.04 mg/L	
Hydrogen sulphide	0–0.3 mg/L				0–0.3 mg/L	
Iron	<0.1 mg/L		<0.5 mg/L	<0.5 mg/L	<0.1 mg/L	<0.1 mg/L
Spawning temperature °C	Marine		23–28	23–28	>24 for more than three days	

Source: Department of Primary Industries and Fisheries: Water Quality in Aquaculture—DPI Notes April 2004.

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

Water parameter	Barramundi		Tiger prawn		Kuruma prawn
	Hatchery	Grow out	Hatchery	Grow out	Grow out
Dissolved oxygen	Saturation	>4 mg/L	>4 mg/L	>3.5 mg/L	>4 mg/L
Temperature °C	28–30 optimum 25–31 range	28–30 optimum		26–32	24
pH	~8	~8	~8	7.5–8.5	7.5–8.5
Ammonia (TAN, total ammonia-nitrogen)		0.1–0.5 mg/L			
Ammonia (NH ₃ , un-ionised form)	<0.1 mg/L	<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	<1.0 mg/L
Nitrite (NO ₂)	<0.2 mg/L	<1.0 mg/L	<0.2 mg/L	<0.2 mg/L	<0.2 mg/L
Salinity	28–31 ppt	0–35 ppt		10–25 ppt optimum	30–35 ppt optimum
Alkalinity		105–125 mg/L CaCO ₃			
Clarity				30–40 cm Secchi disk	30–40 cm Secchi disk
Hydrogen sulphide		<0.3 mg/L			
Iron		<0.02 mg/L		<1.0 mg/L	
Spawning temperature °C		28–32		27–32	

Source: Department of Primary Industries and Fisheries—Water Quality in Aquaculture—DPI Notes April 2004 (as amended).

Table 8 Irrigation EV: Water quality objectives for thermotolerant (faecal) coliforms in irrigation waters used for food and non-food crops¹

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, i.e. 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 (1999).
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.

Table 9 Irrigation EV: Water quality objectives for heavy metals and metalloids in agricultural irrigation water¹—long-term trigger value (LTV), short-term trigger value (STV) and soil cumulative contamination loading limit (CCL)

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.

Table 10 Stock watering EV: Water quality objectives for tolerances of livestock to total dissolved solids (salinity) in drinking water¹

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: AWQG, Volume 1, Section 4.3.3.5, Table 4.3.1.

Table 11 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 AWQG, 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: AWQG, Volume 1, Section 4.3.4, Table 4.3.2.

Table 12 Recreational waters: Alert levels and corresponding actions for management of cyanobacteria

When cyanobacteria are present in large numbers they can present a significant hazard, particularly to primary contact users of waters. Water quality objectives for cyanobacteria in recreational waters are provided in Table 3. Monitoring/action requirements 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.

Green level surveillance mode ¹	Amber level alert mode ¹	Red level action mode ¹
Fresh waters		
≥ 500 to <5000 cells/mL <i>M. aeruginosa</i> or biovolume equivalent of >0.04 to <0.4 mm ³ /L for the combined total of all cyanobacteria.	≥ 5000 to <50 000 cells/mL <i>M. aeruginosa</i> or 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 . or ³ ≥ 0.4 to <10 mm ³ /L for the combined total of all cyanobacteria where known toxin producers are not present.	Level 1 guideline ⁴ : ≥ 10 µg/L total microcystins or ≥ 50 000 cells/mL toxic <i>M. aeruginosa</i> 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. or ³ Level 2 guideline ⁴ : ≥ 10 mm ³ /L for total biovolume of all cyanobacterial material where known toxins are not present. or cyanobacterial scums are consistently present ⁵ .
Coastal and estuarine waters		
<i>Karenia brevis</i>		
≤ 1 cell/mL	> 1 – < 10 cells/mL	≥ 10 cells/mL
<i>Lyngbya majuscula</i> , <i>Pfiesteria</i> spp.		
History but no current presence of organism	Present in low numbers	Present in high numbers. (For <i>Lyngbya majuscula</i> this involves the relatively widespread visible presence of dislodged algal filaments in the water and washed up onto the beach)
<i>Nodularia spumigena</i> : See NHMRC, Chapter 6 (Cyanobacteria and algae in fresh water) for details.		

Notes:

- 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):
 - 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*, *Anabaena circinalis*, *Cylindrospermopsis raciborskii*, *Aphanizomenon ovalisporum*, *Nodularia spumigena*); or fortnightly for other types including regular visual inspection of water surface for scums.
 - 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.
 - 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).
- 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 (microcystins, 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).

4 Ways to improve water quality

The following documents are relevant in considering ways to improve water quality. 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 plans, studies

- Council planning scheme and supporting codes, policies, available DSDIP website and council websites

Regional plans, studies

- Central Queensland Regional Plan, available from the DSDIP website
- Central Queensland Regional Water Supply Strategy, available from the DEWS website

State plans, policies, guidelines, agreements

- Reef Water Quality Protection Plan, Australian and Queensland governments, available from the Reef Water Quality Protection Plan's website
- State Planning Policy (state interest – water quality), including SPP code – water quality, and supporting SPP guidelines, available from the DSDIP website

Water quality guidelines

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (AWQG)
- Monitoring and Sampling Manual, available from the department's website
- Queensland Water Quality Guidelines (QWQG), available from the department's website
- Water quality guidelines for the Great Barrier Reef Marine Park 2010, available on the Great Barrier Reef Marine Park Authority's website

Other supporting technical information – riparian management

- Healthy Waterways Incorporated – Water by Design: resources and information available on the Water by Design website, including content on the Reef Urban Stormwater Management Improvement Group (RUSMIG)
- Managing riparian widths to achieve multiple objectives, fact sheet 13, Land and Water Australia, Australian Government, 2004
- Improving water quality, fact sheet 3, Land & Water Australia, Australian Government, 2002
- Riparian Land Management Technical Guidelines—Volume 1 and 2, November 1999, Land and Water Resources Research and Development Corporation (LWRRDC)
- Guidelines for Queensland Streambank Stabilisation with Riparian Vegetation, CRC for Catchment Hydrology, September 1999
- Restoration of Fish Habitats—Fisheries Guidelines for Marine Areas, FHG002, available from the Department of Agriculture, Fisheries and Forestry
- Fisheries Guidelines for Fish Habitat Buffer Zones, FHG003, available from the Department of Agriculture, Fisheries and Forestry
- Guidelines for Riparian Filter Strips for Queensland Irrigators, CSIRO Land and Water, September 1999

5 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.

Aquatic ecosystems (defined in the AWQG) comprise the animals, plants and micro-organisms that live in water, and the physical and chemical environment and climatic regime in which they interact. It is predominantly the physical components (e.g. light, temperature, mixing, flow, habitat) and chemical components (e.g. organic and inorganic carbon, oxygen, nutrients) of an ecosystem that determine what lives and breeds in it, and therefore the structure of the food web. Biological interactions (e.g. grazing and predation) can also play a part in structuring many aquatic ecosystems.

ARMCANZ means the Agriculture and Resource Management Council of Australia and New Zealand.

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

Biological integrity, of water, means the water's ability 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 is situated.

Biotoxin (defined in the AWQG): means a toxin (poison) which originates from a living thing (a plant, animal, fungi, bacteria, etc.).

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 subcatchments.

Ecological health (defined in the AWQG) means the 'health' or 'condition' of an ecosystem. It is 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 (also termed ecological integrity).

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 Table 13.

Highest astronomical tide (HAT) (defined in Marine Parks (Declaration) Regulation 2006) means the highest level of the tides that can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions.

High water mark (defined in *Coastal Protection and Management Act 1995*) means the ordinary high water mark at spring tides.

Mean high water spring refer high water mark.



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 AWQG): means a chemical capable of producing an adverse response (effect) in a biological system at concentrations that might be encountered in the environment, seriously injuring structure or function or producing death. Examples include pesticides, heavy metals and biotoxins.

Table 13 Suite of environmental values that can be chosen for protection

Environmental values and definitions	ICON (as shown on plans)
<p>Aquatic ecosystem 'A community of organisms living within or adjacent to water, including riparian or foreshore area.' (EPP (Water), schedule 2 - Dictionary) 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. 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. (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).</p>	
<p>High ecological/conservation value waters 'Waters in which the biological integrity of the water is effectively unmodified or highly valued.' (EPP (Water), schedule 2).</p>	None
<p>Slightly disturbed waters '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), schedule 2).</p>	None
<p>Moderately disturbed waters 'Waters in which the biological integrity of the water is adversely affected by human activity to a relatively small but measurable degree.' (EPP (Water), schedule 2).</p>	None
<p>Highly disturbed waters '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), schedule 2).</p>	None
<p>Seagrass (goal within the aquatic ecosystem EV) Maintenance or rehabilitation of seagrass habitat. (Applies only to tidal waterways.)</p>	

Environmental values and definitions	ICON (as shown on plans)
<p>Irrigation Suitability of water supply for irrigation, for example, irrigation of crops, pastures, parks, gardens and recreational areas.</p>	
<p>Farm water supply/use Suitability of domestic farm water supply, other than drinking water. For example, water used for laundry and produce preparation.</p>	
<p>Stock watering Suitability of water supply for production of healthy livestock.</p>	
<p>Aquaculture Health of aquaculture species and humans consuming aquatic foods (such as fish, molluscs and crustaceans) from commercial ventures.</p>	
<p>Human consumers of aquatic foods Health of humans consuming aquatic foods, such as fish, crustaceans and shellfish from natural waterways. Note that in some areas oystering is a more specific goal identified under the human consumer EV (see below).</p>	
<p>Oystering (goal within the EV of human consumers of aquatic foods) Health of humans consuming oysters from natural waterways and commercial ventures. (Applies only to tidal waterways.)</p>	
<p>Primary recreation Health of humans during recreation which involves direct contact and a high probability of water being swallowed, for example, swimming, surfing, windsurfing, diving and water-skiing. Primary recreational use, of water, means full body contact with the water, including, for example, diving, swimming, surfing, waterskiing and windsurfing. (EPP (Water), s. 6).</p>	
<p>Secondary recreation Health of humans during recreation which involves indirect contact and a low probability of water being swallowed, for example, wading, boating, rowing and fishing. Secondary recreational use, of water, means contact other than full body contact with the water, including, for example, boating and fishing. (EPP (Water), s. 6).</p>	
<p>Visual recreation Amenity of waterways for recreation which does not involve any contact with water—for example, walking and picnicking adjacent to a waterway. Visual recreational use, of a water, means viewing the water without contact with it. (EPP (Water), s. 6).</p>	

Environmental values and definitions	ICON (as shown on plans)
<p>Drinking water supply Suitability of raw drinking water supply. This assumes minimal treatment of water is required, for example, coarse screening and/or disinfection.</p>	
<p>Industrial use Suitability of water supply for industrial use, for example, food, beverage, paper, petroleum and power industries, mining and minerals refining/processing. Industries usually treat water supplies to meet their needs.</p>	
<p>Cultural and spiritual values Indigenous and non-indigenous cultural heritage, for example:</p> <ul style="list-style-type: none"> • custodial, spiritual, cultural and traditional heritage, hunting, gathering and ritual responsibilities • symbols, landmarks and icons (such as waterways, turtles and frogs) • lifestyles (such as agriculture and fishing). <p>Cultural and spiritual values, of water, means its aesthetic, historical, scientific, social or other significance, to the present generation or past or future generations. (EPP (Water), s. 6).</p>	

7.1 WATER QUALITY OBJECTIVES FOR SURFACE AND GROUNDWATERS – IONIC INDICATORS

Table 14 Capricorn-Curtis Coast region surface and groundwater ions: water quality objectives (aquatic ecosystem) according to water chemistry zone and depth

SURFACE WATER

Eastern Shoalwater Basin and Water Park Creek Basin (outside Defence Practice Area)

Flow ¹	Percentile	Indicator ² and water quality objective (WQO)																	
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		EC	Hardness (mg·L ⁻¹)	Alkalinity (mg·L ⁻¹)	SiO ₂ (mg·L ⁻¹)	F (mg·L ⁻¹)	SAR
		mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	µS·cm ⁻¹					
normal	25th	15	-	1	-	2	-	5	-	27	-	2	-	107	9	4.0	7.23	0.05	2.10
	75th	21	-	1	-	3	-	9	-	35	-	3	-	141	14	8.0	10.08	0.10	2.40

72 Note:

1. Normal flow conditions exclude the top and bottom 10% of flows

2. Abbreviations: Na: Sodium, Ca: Calcium, Mg: Magnesium, HCO₃: Bicarbonate, Cl: Chloride, SO₄: Sulfate, EC: Electrical conductivity, SiO₂: Silica, F: Fluoride, SAR: Sodium adsorption ratio, '-': insufficient data to perform statistical summaries, or the parameter was not tested.

Source: WQOs for these indicators are based on DSITIA analysis of data collected as part of the Queensland Government Surface Water Ambient Network (SWAN) monitoring program, and stored on the 'Hydstra' database. Prepared for EHP by DSITIA,

McNeil V.H. and Raymond M.A. (2014) Regional groundwater chemistry zones of the Curtis and Capricorn Coast: Draft Technical Notes. Department of Science, Information Technology, Innovation and the Arts, Queensland

McNeil V. H and Clarke R. (2004) Salinity zones defined for Queensland streams. Report prepared for Queensland Water Quality Guidelines, Appendix G.

GROUNDWATER (refer to plan WQ 1273)

Zone 1 – Banksia^{1, 2, 3, 4}

Depth ²	Percentile ³	Indicator ⁴ and water quality objective (WQO)																									
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		NO ₃		EC	Hardness (mg·L ⁻¹)	pH	Alkalinity (mg·L ⁻¹)	SiO ₂ (mg·L ⁻¹)	F (mg·L ⁻¹)	Fe (mg·L ⁻¹)	Mn (mg·L ⁻¹)	Zn (mg·L ⁻¹)	Cu (mg·L ⁻¹)	SAR	RAH (meq·L ⁻¹)
		mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	µS·cm ⁻¹											
moderate	20th	558	79	5	1	20	6	215	13	771	66	26	1			2,864	96	7.8	180.6	107	0.22					19.12	1.13
	50th	570	91	12	2	24	7	220	14	840	83	30	2	1.50	0	3,050	127	8.1	186.0	109	0.35					22.00	1.87
	80th	1,096	93	43	3	134	17	1,251	33	1,394	85	44	2	3.00	0	5,705	657	8.3	1,026.6	110	0.76					24.79	7.46

Note: insufficient data to derive WQOs for shallow and artesian depth profiles. Refer to all notes after zone 15.

Zone 2 – Coorooman ^{1, 2, 3, 4}

Depth ²	Percentile ³	Indicator ⁴ and water quality objective (WQO)																									
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		NO ₃		EC	Hardness (mg·L ⁻¹)	pH	Alkalinity (mg·L ⁻¹)	SiO ₂ (mg·L ⁻¹)	F (mg·L ⁻¹)	Fe (mg·L ⁻¹)	Mn (mg·L ⁻¹)	Zn (mg·L ⁻¹)	Cu (mg·L ⁻¹)	SAR	RAH (meq·L ⁻¹)
		mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	μS·cm ⁻¹											
moderate	20th	295	41	69	14	57	20	185	8	634	79	34	2	0.18	0	2,581	396	7.1	153.5	37	0.29		0.001	0.015	0.005	4.45	
	50th	403	56	139	19	125	25	262	12	1,100	84	58	3	1.40	0	3,845	877	8.0	221.0	40	0.40		0.030	0.030	0.020	6.50	
	80th	673	62	224	26	166	32	368	17	1,580	89	105	5	1.77	0	5,279	1,197	8.3	304.5	50	0.57		0.106	0.105	0.035	9.55	

Note: insufficient data to derive WQOs for shallow depth profile. Refer to all notes after zone 15.

37

Zone 3 - Styx ^{1, 2, 3, 4}

Depth ²	Percentile ³	Indicator ⁴ and water quality objective (WQO)																									
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		NO ₃		EC	Hardness (mg·L ⁻¹)	pH	Alkalinity (mg·L ⁻¹)	SiO ₂ (mg·L ⁻¹)	F (mg·L ⁻¹)	Fe (mg·L ⁻¹)	Mn (mg·L ⁻¹)	Zn (mg·L ⁻¹)	Cu (mg·L ⁻¹)	SAR	RAH (meq·L ⁻¹)
		mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	μS·cm ⁻¹											
shallow	20th	781	44	95	6	163	17	326	5	1,727	70	164	4			6,445	867	7.5	272.5	23	0.32		0.035	0.039		7.60	
	50th	1,296	71	222	11	209	18	583	11	2,342	84	301	8	0.00	0	7,620	1,346	7.7	478.5	30	0.68		0.165	0.140	0.010	15.30	
	80th	1,564	77	315	21	310	36	628	15	3,607	88	653	15	3.26	0	9,887	1,995	8.0	524.5	33	1.07	0.09	0.478	12.666	0.041	22.60	
moderate	20th	763	61	35	2	137	18	52	1	1,617	78	18	1	0.65	0	5,457	711	5.1	42.5	30	0.47		0.105	0.144	0.071	11.25	
	50th	1,062	76	70	4	185	21	105	2	2,094	92	100	3	2.00	0	7,380	1,121	7.2	86.0	43	0.60		0.330	0.900	0.080	13.90	
	80th	1,650	78	235	18	211	22	793	20	3,045	96	278	6	5.50	0	9,490	1,302	7.6	653.5	79	1.08	0.34	1.878	1.035	0.476	22.60	

Note: insufficient data to derive WQOs for deep and very deep depth profiles. Refer to all notes after zone 15.

Zone 4 - Yeppoon ^{1, 2, 3, 4}

Depth ²	Percentile ³	Indicator ⁴ and water quality objective (WQO)																									
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		NO ₃		EC	Hardness (mg·L ⁻¹)	pH	Alkalinity (mg·L ⁻¹)	SiO ₂ (mg·L ⁻¹)	F (mg·L ⁻¹)	Fe (mg·L ⁻¹)	Mn (mg·L ⁻¹)	Zn (mg·L ⁻¹)	Cu (mg·L ⁻¹)	SAR	RAH (meqL ⁻¹)
		mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	μS·cm ⁻¹											
very shallow	20th	198	48	24	4	32	14	23	2	482	83	10	1	0.67	0	1,695	191	7.5	22.9	6	0.01	0.02				4.10	
	50th	265	77	24	8	56	15	49	4	630	93	10	1	2.20	0	2,100	290	7.6	40.0	10	0.10	0.02	0.010			8.60	
	80th	603	82	60	16	83	36	153	16	1,098	97	20	2	4.90	0	3,450	492	9.0	125.5	17	0.10	0.02	0.020			15.71	
moderate	20th	236	73	29	10	25	15	122	14	398	73	12	2	0.50	0	1,506	181	6.3	100.9	27	0.26		0.010	0.006		7.53	
	50th	264	74	34	11	29	15	133	15	477	83	14	2	1.05	0	1,747	208	7.4	110.0	44	0.31	0.01	0.230	0.020	0.015	8.35	
	80th	472	76	46	12	51	16	390	24	717	84	36	3	2.27	0	2,720	316	7.9	330.0	48	0.77	0.03	0.433	0.039	0.015	10.32	0.07
deep	20th	289	79	20	5	17	6	123	10	465	78	5	1	-	-	1,725	127	7.0	100.5		0.30					9.72	
	50th	368	85	24	5	22	10	128	11	596	89	7	1	0.05	0	1,950	140	7.6	105.0		0.45					13.50	
	80th	445	88	28	9	25	13	202	20	699	90	13	2	0.10	0	2,265	170	8.1	168.0		0.60					17.19	

Note: insufficient data to derive WQOs for shallow depth profile. Refer to all notes after zone 15.

Zone 5 -Pacific ^{1, 2, 3, 4}

Depth ²	Percentile ³	Indicator ⁴ and water quality objective (WQO)																									
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		NO ₃		EC	Hardness (mg·L ⁻¹)	pH	Alkalinity (mg·L ⁻¹)	SiO ₂ (mg·L ⁻¹)	F (mg·L ⁻¹)	Fe (mg·L ⁻¹)	Mn (mg·L ⁻¹)	Zn (mg·L ⁻¹)	Cu (mg·L ⁻¹)	SAR	RAH (meqL ⁻¹)
		mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	μS·cm ⁻¹											
shallow	20th	703	68	133	6	98	18	149	0	1,407	79	56	4			4,818	735	6.0	152.4	20	0.20		0.102	0.026	0.064	11.32	
	50th	8,900	71	635	6	1,475	21	265	1	16,500	86	3,100	11	7.20	0	40,000	8,194	7.3	230.0	25	0.43	0.06	1.900	0.040	0.210	41.90	
	80th	11,072	76	785	10	1,857	23	396	9	19,705	89	5,231	15	23.20	0	49,050	9,295	7.5	335.9	33	0.51	0.96	5.707	0.236	0.279	47.80	

Note: insufficient data to derive WQOs for moderate depth profile. Refer to all notes after zone 15.

Zone 6 - Jacob ^{1, 2, 3, 4}

Depth ²	Percentile ³	Indicator ⁴ and water quality objective (WQO)																									
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		NO ₃		EC	Hardness (mg·L ⁻¹)	pH	Alkalinity (mg·L ⁻¹)	SiO ₂ (mg·L ⁻¹)	F (mg·L ⁻¹)	Fe (mg·L ⁻¹)	Mn (mg·L ⁻¹)	Zn (mg·L ⁻¹)	Cu (mg·L ⁻¹)	SAR	RAH (meqL ⁻¹)
		mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	μS·cm ⁻¹											
shallow	20th	1,548	64	189	8	297	21	441	6	3,470	92	4	0	-	-	12,000	1,650	7.5	361.1	21	0.10	0.95				15.46	
	50th	1,925	66	253	10	376	24	457	7	4,300	93	10	0	0.85	0	12,000	2,209	7.7	396.5	23	0.20	1.95				17.95	
	80th	2,508	68	282	12	455	25	641	8	5,117	94	85	1	2.65	0	12,000	2,509	8.4	525.2	24	0.30	2.75				21.56	
moderate	20th	77	47	3	4	8	16	24	9	144	51	2	1			654	40	5.8	20.0		0.01	-				5.30	
	50th	220	64	93	15	55	21	377	22	373	71	91	6			1,852	459	6.3	311.5		0.06	1.00				5.30	
	80th	364	81	182	27	103	25	730	36	603	90	180	11			3,050	878	6.7	603.0		0.10	2.00				5.30	
deep	20th	906	65	91	5	103	14	551	5	1,254	64	126	4	0.40	0	4,376	746	7.0	451.5		0.30	0.25				12.11	2.61
	50th	1,456	72	160	8	178	18	638	17	2,280	75	215	7	4.00	0	6,790	979	7.1	528.5		0.70	0.64				19.65	5.48
	80th	4,060	77	317	17	630	23	1,245	32	7,335	86	446	8	14.71	0	18,440	3,180	7.5	1,021.2		1.82	8.35				29.89	8.30

Note: insufficient data to derive WQOs for very shallow depth profile. Refer to all notes after zone 15.

Zone 7 - Woodbury ^{1, 2, 3, 4}

Depth ²	Percentile ³	Indicator ⁴ and water quality objective (WQO)																										
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		NO ₃		EC	Hardness (mg·L ⁻¹)	pH	Alkalinity (mg·L ⁻¹)	SiO ₂ (mg·L ⁻¹)	F (mg·L ⁻¹)	Fe (mg·L ⁻¹)	Mn (mg·L ⁻¹)	Zn (mg·L ⁻¹)	Cu (mg·L ⁻¹)	SAR	RAH (meq·L ⁻¹)	
		mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹												%
shallow	20th	16	63	1	4	1	11	2	3	16	38	5	10			119	8	4.8	6.0	11					0.020		1.68	
	50th	18	79	1	6	2	15	8	12	18	48	10	21	11.50	10	120	10	6.5	8.0	12		0.03			0.045	0.005	2.30	
	80th	20	83	3	14	4	22	13	24	27	59	28	36	13.42	21	170	23	6.8	11.8	13	0.10	0.05	0.010	0.070	0.010	2.87	0.02	
deep	20th	525	57	197	23	91	18	300	11	689	45	765	38	0.75	0	3,775	866	7.0	249.0	26	0.35	0.02	0.006			7.70		
	50th	660	57	230	23	120	19	340	12	880	47	1,000	41	2.20	0	4,620	1,069	7.9	285.0	36	0.40	0.06	0.260			8.60		
	80th	700	58	261	25	128	20	389	13	896	49	1,164	43	3.60	0	4,900	1,169	7.9	324.0	38	0.55	0.14	1.361			8.95		

Note: refer to all notes after zone 15.

Zone 8 - Welton ^{1, 2, 3, 4}

Depth ²	Percentile ³	Indicator ⁴ and water quality objective (WQO)																										
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		NO ₃		EC	Hardness (mg·L ⁻¹)	pH	Alkalinity (mg·L ⁻¹)	SiO ₂ (mg·L ⁻¹)	F (mg·L ⁻¹)	Fe (mg·L ⁻¹)	Mn (mg·L ⁻¹)	Zn (mg·L ⁻¹)	Cu (mg·L ⁻¹)	SAR	RAH (meq·L ⁻¹)	
		mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹												%
shallow	20th	17	66	2	5	3	15	5	3	28	64	4	4			145	15	5.7	4.0	6				0.010	0.030		1.90	
	50th	35	73	4	8	5	18	15	12	56	74	10	9	0.50	0	261	29	6.5	12.0	15	0.10	0.02	0.055	0.060		2.70		
	80th	59	79	7	13	8	22	36	22	93	82	16	19	2.20	3	384	50	7.0	30.3	22	0.10	0.41	0.160	0.138	0.010	4.00		
moderate	20th	50	72	3	4	3	6	65	24	50	40	4	2			289	21	7.0	53.5	35	0.21			0.010		3.49	0.49	
	50th	74	80	7	8	6	11	117	41	70	54	8	4	0.28	0	436	38	7.4	97.0	58	0.42	0.01	0.010	0.020	0.005	5.30	1.16	
	80th	175	89	16	14	11	15	196	53	205	71	17	6	1.40	0	950	87	7.8	160.4	66	0.63	0.18	0.159	0.050	0.015	8.90	2.01	
deep	20th	25	66	3	7	3	12	30	22	38	49	3	2			187	18	6.7	24.5	28	0.14			0.030	0.005	2.21	0.05	
	50th	63	75	7	9	6	15	59	38	68	60	6	3	0.30	0	410	45	7.7	48.0	46	0.22			0.030	0.010	4.00	0.50	
	80th	97	81	12	12	9	20	162	46	106	75	11	8	1.10	0	592	66	8.0	134.3	62	0.49	0.00	0.408	0.100	0.020	6.36	1.62	

Note: refer to all notes after zone 15.

Zone 9 - Leixlip ^{1, 2, 3, 4}

Depth ²	Percentile ³	Indicator ⁴ and water quality objective (WQO)																										
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		NO ₃		EC	Hardness (mg.L ⁻¹)	pH	Alkalinity (mg.L ⁻¹)	SiO ₂ (mg.L ⁻¹)	F (mg.L ⁻¹)	Fe (mg.L ⁻¹)	Mn (mg.L ⁻¹)	Zn (mg.L ⁻¹)	Cu (mg.L ⁻¹)	SAR	RAH (meqL ⁻¹)	
		mg.L ⁻¹	%	mg.L ⁻¹	%	mg.L ⁻¹	%	mg.L ⁻¹	%	mg.L ⁻¹	%	mg.L ⁻¹	%	mg.L ⁻¹	%	µS.cm ⁻¹												
very shallow	20th	303	48	52	10	92	28	705	49	308	31	30	2			2,500	567	7.7	638.8	33	0.61						4.96	1.59
	50th	324	51	87	16	108	34	966	55	370	36	45	3	3.60	0	2,615	682	7.8	792.0	34	1.10	0.05					5.40	3.11
	80th	343	57	104	20	124	35	1,074	65	441	47	87	6	6.60	0	2,730	711	8.6	880.1	35	1.47	0.86					6.27	4.77
shallow	20th	299	54	36	7	46	13	574	23	200	26	32	3			1,960	309	7.6	474.7	24	0.20				0.010	5.85	1.35	
	50th	425	67	74	14	68	20	752	52	430	42	85	6	1.80	0	2,450	469	7.9	627.0	27	0.60	0.30	0.005	0.010	0.015	9.00	6.07	
	80th	639	76	137	22	99	28	983	69	966	65	146	10	31.00	2	3,500	651	8.3	843.3	45	0.90	1.23	0.020	0.092	0.110	12.30	10.99	
moderate	20th	391	57	61	8	61	16	275	9	369	37	73	4			2,759	487	7.2	228.2	30	0.20			0.002	0.001	7.30	0.24	
	50th	500	63	120	13	84	20	788	38	634	56	110	7	0.30	0	3,640	632	7.8	681.0	32	0.40	0.10	0.055	0.020	0.010	9.60	3.73	
	80th	898	71	187	26	178	23	923	55	1,319	80	217	9	15.15	2	7,839	909	8.3	837.9	44	0.90	0.46	0.562	0.047	0.028	13.18	7.70	
deep	20th	832	74	20	2	24	5	567	11	628	45	47	2			4,111	148	7.1	492.1		0.91	0.10				17.59	0.47	
	50th	850	80	53	6	77	14	808	21	1,150	73	105	5			4,300	449	8.0	664.0		1.00	0.50				22.90	9.85	
	80th	2,065	93	203	8	269	18	1,262	52	3,580	82	371	6			10,690	1,614	8.5	1,034.8		1.99	21.65				33.43	19.22	

Note: refer to all notes after zone 15.

Zone 10 - Uplands ^{1, 2, 3, 4}

Depth ²	Percentile ³	Indicator ⁴ and water quality objective (WQO)																									
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		NO ₃		EC	Hardness (mg·L ⁻¹)	pH	Alkalinity (mg·L ⁻¹)	SiO ₂ (mg·L ⁻¹)	F (mg·L ⁻¹)	Fe (mg·L ⁻¹)	Mn (mg·L ⁻¹)	Zn (mg·L ⁻¹)	Cu (mg·L ⁻¹)	SAR	RAH (meqL ⁻¹)
		mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	μS·cm ⁻¹											
Very shallow	20th	44	31	34	27	12	14	171	55	41	13	8	3	0.10	0	495	158	7.5	141.0	25	0.11			0.005		1.40	
	50th	60	37	55	39	17	24	266	64	64	29	22	6	1.00	0	680	234	7.8	220.0	30	0.20	0.01	0.010	0.010	0.010	1.70	0.40
	80th	100	44	84	47	39	28	506	77	97	39	44	9	7.00	1	970	350	8.1	417.6	36	0.50	0.04	0.010	0.045	0.015	2.60	2.31
moderate	20th	85	33	56	21	34	25	449	65	49	13	13	2	2.25	0	899	314	7.5	370.9	31	0.35			0.010	0.010	1.90	0.51
	50th	93	36	79	35	38	27	511	74	75	18	33	6	7.70	1	1,050	376	7.8	422.0	35	0.58	0.01		0.020	0.020	2.10	1.43
	80th	108	41	98	41	64	35	590	81	111	31	38	7	11.27	2	1,225	431	8.0	486.2	51	0.60	0.03	0.010	0.068	0.030	2.60	1.84

Note: insufficient data to derive WQOs for very deep depth profile. Refer to all notes after zone 15.

Zone 11 - Cawarral ^{1, 2, 3, 4}

Depth ²	Percentile ³	Indicator ⁴ and water quality objective (WQO)																									
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		NO ₃		EC	Hardness (mg·L ⁻¹)	pH	Alkalinity (mg·L ⁻¹)	SiO ₂ (mg·L ⁻¹)	F (mg·L ⁻¹)	Fe (mg·L ⁻¹)	Mn (mg·L ⁻¹)	Zn (mg·L ⁻¹)	Cu (mg·L ⁻¹)	SAR	RAH (meqL ⁻¹)
		mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	μS·cm ⁻¹											
shallow	20th	38	20	38	15	42	36	328	58	71	20	20	4	0.62	0	774	330	7.5	275.0	28	0.09			0.010	0.010	0.87	
	50th	66	26	42	25	66	46	475	72	95	23	26	4	4.40	1	960	417	7.7	391.0	37	0.15			0.320	0.165	1.50	
	80th	77	31	78	45	90	59	563	75	115	39	26	6	9.89	2	1,052	472	8.0	461.6	43	0.16			0.630	0.320	1.53	0.41
moderate	20th	30	14	30	16	67	49	394	76	48	11	18	4	2.06	0	817	380	7.7	330.7	64	0.02			0.050	0.030	0.63	
	50th	45	16	59	28	72	51	528	78	55	17	19	4	9.80	2	949	420	8.0	436.0	75	0.12			0.345	0.080	0.90	
	80th	52	21	81	34	75	69	580	79	65	18	34	6	36.35	5	1,057	494	8.3	482.8	86	0.16			0.640	0.130	1.08	0.28

Note: insufficient data to derive WQOs for very deep depth profiles. Refer to all notes after zone 15.

Zone 12 - Emu ^{1, 2, 3, 4}

Depth ²	Percentile ³	Indicator ⁴ and water quality objective (WQO)																									
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		NO ₃		EC	Hardness (mg·L ⁻¹)	pH	Alkalinity (mg·L ⁻¹)	SiO ₂ (mg·L ⁻¹)	F (mg·L ⁻¹)	Fe (mg·L ⁻¹)	Mn (mg·L ⁻¹)	Zn (mg·L ⁻¹)	Cu (mg·L ⁻¹)	SAR	RAH (meq·L ⁻¹)
		mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	µS·cm ⁻¹											
Very shallow	20th	40	44	18	27	6	13	76	32	58	42	10	5	0.43	0	368	77	7.3	62.1	10						1.83	
	50th	42	49	29	36	7	15	105	40	64	51	12	7	0.60	0	420	99	7.5	87.0	14	0.10	0.01	0.010	0.505		2.00	
	80th	71	55	59	40	21	20	134	48	116	54	116	13	1.35	1	749	233	7.9	110.7	16	0.10	0.10	0.024	1.010		2.10	0.08
shallow	20th	39	40	29	24	7	11	105	31	51	28	5	2			448	119	7.2	92.2	11	0.01					1.60	
	50th	75	47	47	36	12	15	185	45	114	46	15	5	0.60	0	720	176	7.9	157.0	16	0.10	0.01	0.010	0.010		2.30	
	80th	110	59	68	45	21	22	280	59	166	57	35	12	2.03	0	935	250	8.1	230.9	20	0.18	0.05	0.200	0.020	0.015	3.30	0.36
moderate	20th	52	51	5	3	3	2	115	30	80	40	6	2	0.11	0	449	25	7.2	94.5	23	0.18			0.005		2.40	
	50th	139	74	15	12	8	13	244	37	140	58	13	3	0.50	0	820	65	8.0	202.5	28	0.27	0.01	0.010	0.010		10.90	1.10
	80th	287	95	44	26	26	22	282	54	355	67	41	5	1.78	0	1,564	224	8.2	235.0	55	0.92	0.06	0.010	6.360	0.020	20.47	3.94
deep	20th	40	44	14	19	11	24	41	35	49	38	2	0	0.10	0	333	92	6.7	75.3		0.17	0.06				1.90	0.06
	50th	58	49	25	23	16	29	116	52	74	47	5	1	2.45	0	468	120	7.5	114.0		0.24	0.10				2.40	0.61
	80th	132	54	55	26	47	34	188	61	344	65	7	2	4.80	0	1,254	330	8.5	154.0		0.34	0.46				3.03	0.69

Note: refer to all notes after zone 15.

Zone 13 - Bracewell ^{1, 2, 3, 4}

Depth ²	Percentile ³	Indicator ⁴ and water quality objective (WQO)																									
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		NO ₃		EC	Hardness (mg·L ⁻¹)	pH	Alkalinity (mg·L ⁻¹)	SiO ₂ (mg·L ⁻¹)	F (mg·L ⁻¹)	Fe (mg·L ⁻¹)	Mn (mg·L ⁻¹)	Zn (mg·L ⁻¹)	Cu (mg·L ⁻¹)	SAR	RAH (meqL ⁻¹)
		mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	µS·cm ⁻¹											
very shallow	20th	179	45	48	15	32	11	425	45	155	22	36	6			759	365	7.8	353.9	23	0.20	0.20	0.010			3.27	1.78
	50th	238	53	81	23	67	26	638	63	213	29	83	10	5.00	0	1,650	472	8.1	594.5	25	0.40	0.30	0.015			5.10	3.52
	80th	301	59	121	33	90	31	853	74	328	43	128	12	5.93	1	2,065	598	8.4	741.0	27	0.60	0.89	0.020			6.03	6.03
shallow	20th	150	39	70	17	32	15	361	23	177	31	35	4			1,400	370	7.4	305.0	23	0.10	0.03		0.001	0.002	3.00	
	50th	220	48	120	30	57	23	542	41	355	47	88	8	6.00	1	1,715	554	7.7	452.0	28	0.30	0.30	0.010	0.010	0.015	4.20	0.83
	80th	430	60	192	39	89	29	690	58	779	70	149	12	23.00	2	2,630	809	8.1	582.6	31	0.40	2.20	0.010	0.019	0.020	7.31	3.25
moderate	20th	65	43	26	13	12	16	91	16	84	29	8	3	2.65	0	489	120	6.9	81.0	20	0.10			0.020		2.60	
	50th	170	51	68	28	31	20	355	31	242	56	40	7	8.15	1	1,160	341	7.5	300.5	24	0.20	0.08	0.010	0.030	0.010	3.40	0.34
	80th	315	65	174	37	82	25	573	57	526	75	121	11	22.00	6	2,430	696	7.9	476.5	30	0.30	1.10	0.020	0.075	0.055	6.00	1.84
deep	20th	171	41	127	28	40	11	378	18	315	52	40	3	0.04	0	1,793	535	6.9	315.9	18	0.10	0.01		0.020		3.40	
	50th	305	46	225	35	56	16	462	25	790	71	85	5	1.30	0	3,150	773	7.3	381.0	22	0.20	0.32		0.030		4.90	0.15
	80th	512	57	280	44	80	19	569	44	1,213	76	126	9	10.30	1	4,327	1,007	7.7	481.3	24	0.30	4.65	0.026	0.220	0.080	7.20	0.55
very deep	20th	240	42	154	28	36	12	167	11	509	57	29	3	0.05	0	2,200	569	6.8	136.6	15	0.05	0.01		0.013		4.10	
	50th	302	46	221	40	53	15	404	20	721	75	70	4	0.80	0	2,953	765	7.3	334.0	26	0.10	0.12		0.020	0.005	4.55	
	80th	403	54	304	45	66	17	502	30	983	86	112	6	6.45	0	3,586	985	7.8	420.3	30	0.20	5.46	1.960	0.027	0.010	6.47	

Note: refer to all notes after zone 15.

Zone 14 - Boondoola ^{1, 2, 3, 4}

Depth ²	Percentile ³	Indicator ⁴ and water quality objective (WQO)																									
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		NO ₃		EC	Hardness (mg·L ⁻¹)	pH	Alkalinity (mg·L ⁻¹)	SiO ₂ (mg·L ⁻¹)	F (mg·L ⁻¹)	Fe (mg·L ⁻¹)	Mn (mg·L ⁻¹)	Zn (mg·L ⁻¹)	Cu (mg·L ⁻¹)	SAR	RAH (meq·L ⁻¹)
		mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	μS·cm ⁻¹											
shallow	20th	116	44	33	15	29	21	125	18	246	60	7	1			1,119	207	7.2	102.5	44	0.19			0.013	-	2.65	
	50th	144	50	40	18	41	30	186	27	270	68	22	4	0.80	0	1,307	269	7.5	153.0	62	0.30		0.020	0.020	0.005	3.60	
	80th	248	62	83	23	75	34	312	29	572	79	42	5	11.77	1	1,965	491	7.8	259.3	85	0.33	0.05	0.415	0.034	0.010	5.31	
moderate	20th	108	41	10	8	12	14	66	10	209	65	5	1			863	74	6.5	54.5	31	0.22			0.010		3.10	
	50th	167	50	53	20	48	24	167	22	333	74	15	3	0.90	0	1,460	329	7.4	137.0	51	0.30		0.010	0.020	0.020	4.00	
	80th	258	78	100	31	66	32	326	31	599	87	23	3	2.68	0	2,164	519	7.9	269.0	66	0.57		0.196	0.073	0.042	6.55	0.07
deep	20th	76	54	7	3	4	5	124	25	162	53	6	2	0.03	0	695	40	7.3	102.0	50	0.23	0.00				3.65	2.36
	50th	197	82	11	13	6	5	264	43	199	54	14	3	0.10	0	1,018	47	7.8	223.0	57	0.48	0.02				7.30	3.53
	80th	221	92	45	22	30	24	286	43	217	74	23	4	0.31	0	1,119	234	8.4	238.5	85	0.50	1.35	0.036			14.60	3.70

Note: refer to all notes after zone 15.

Zone 15 - Bison ^{1, 2, 3, 4}

Depth ²	Percentile ³	Indicator ⁴ and water quality objective (WQO)																									
		Na		Ca		Mg		HCO ₃		Cl		SO ₄		NO ₃		EC	Hardness (mg·L ⁻¹)	pH	Alkalinity (mg·L ⁻¹)	SiO ₂ (mg·L ⁻¹)	F (mg·L ⁻¹)	Fe (mg·L ⁻¹)	Mn (mg·L ⁻¹)	Zn (mg·L ⁻¹)	Cu (mg·L ⁻¹)	SAR	RAH (meqL ⁻¹)
		mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	mg·L ⁻¹	%	μS·cm ⁻¹											
shallow	20th	137	33	45	20	31	20	332	26	180	45	29	5			1,060	240	6.8	272.0	30	0.20	0.02				2.20	1.31
	50th	245	46	75	28	52	23	560	43	330	47	49	7			1,800	401	7.6	465.0	30	0.30	0.02				4.20	1.53
	80th	289	57	402	47	106	25	605	49	995	66	153	9			3,675	1,441	8.0	500.0	38	0.50	0.02				5.30	1.74
moderate	20th	384	22	542	38	327	38	210	4	2,200	88	189	6	12.90	0	6,570	2,699	7.2	173.0	29	0.23					3.10	
	50th	390	23	582	39	344	38	237	5	2,337	89	202	6	23.55	0	7,035	2,869	7.4	195.0	31	0.27					3.15	
	80th	396	24	623	40	361	38	263	6	2,474	89	215	6	34.20	1	7,500	3,038	7.5	217.0	33	0.30					3.20	

Note: insufficient data to derive WQOs for shallow depth profile. Refer to all notes below.

Notes:

1. Refer to plan WQ1273 to locate the relevant groundwater chemistry zone.
2. Within each chemistry zone, groundwater quality values are provided for different depths (Very shallow: <5m, Shallow: 5–20m, Moderate: 20–40m, Deep: 40–60m, Very deep: >60m, Artesian: all artesian (max 240m)).
3. The management intent is to maintain 20th, 50th and 80th percentile values. Values are provided for each of these percentiles.
4. Abbreviations: EC: Electrical conductivity, CaCO₃: Calcium carbonate, Ca: Calcium, Mg: Magnesium, Na: Sodium, Cl: Chloride, SO₄: Sulfate, HCO₃: Bicarbonate, NO₃: Nitrate, SiO₂: Silica, F: Fluoride, Fe: Iron, Mn: Manganese, Zn: Zinc, Cu: Copper, SAR: Sodium adsorption ratio, RAH: Residual alkali hazard, EH: Redox (oxidation/reduction) potential, '-': insufficient data to perform statistical summaries, or the parameter was not tested.

Source: McNeil V.H. and Raymond M.A. (2014) Regional groundwater chemistry zones of the Curtis and Capricorn Coast: Draft Technical Notes. Department of Science, Information Technology, Innovation and the Arts, Queensland