Technical Guidance for Water Quality Objectives (WQOs) Setting for Tasmania

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- Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- Cradle Coast NRM
- Derwent Estuary Program (and associated partners)
- Forestry Tasmania
- Hydro Tasmania
- Institute for Marine and Antarctic Studies (IMAS)
- Marine Farming Branch, Department of Primary Industries, Parks, Water and Environment
- NRM North
- Tamar Estuary and Esk Rivers Program (and associated partners)
- Tasmanian Shellfish Quality Assurance, Department of Health and Human Services (DHHS)
- Water Assessment Branch, Department of Primary Industries, Parks, Water and Environment

Foreword

This technical guidance document provides detail on the process for deriving water quality guideline values, and the use of those values in the water quality objective setting process by the EPA Board. It is a technical resource for assessing and managing ambient water quality. Inland, estuarine, coastal and marine surface waters and groundwater represent a single water resource.

The Tasmanian *State Policy on Water Quality Management 1997* (SPWQM) applies the water quality management approach recommended by the *National Water Quality Management Strategy* (NWQMS) and the management framework in the *Australian New Zealand Guideline for Fresh and Marine Water Quality 2018* (ANZG 2018).

Consistent with these national guidelines, the State Policy objectives aim to protect or enhance water quality for the identified protected environmental values for Tasmanian waters. The protection of aquatic ecosystems is a protected environmental value in common to all water types. On this basis, Default Guideline Values (DGVs) for aquatic ecosystems have been developed in accordance with the NWQMS.

Tasmania's surface waters are represented by ephemeral to perennial flowing and standing inland water bodies, small to moderate tidal range estuaries, and coastal and marine regions. Groundwater is intrinsically linked to surface water by aquifers through varying rock types and rock features with varying degrees of connectivity.

Topographic features and climatic zones define the twelve broad Australian Drainage Divisions for inland waters. Tasmanian inland waters are represented by a single national division (Drainage Division 3). DGVs for aquatic ecosystems have been set for the State, four hydrological regions, and for each of the 48 surface water catchments.

For estuarine waters, the ability of the water to flow from rivers to the coast determines the flushing class. Estuaries can be well flushed, poorly flushed or fluctuate between an open or closed state. DGVs for aquatic ecosystems have been set for the State, and for each flushing class and critical event for the estuary type.

For marine and coastal waters, Interim Marine and Coastal Regionalisation of Australia (IMCRA) is the best fit for regionalisation. DGVs for aquatic ecosystems have been set for the State, four IMCRA provincial region and nine IMCRA mesoscale bioregions.

Topographic and geological features and hydrology define the ability of water to flow between groundwater and surface water regions. DGVs for aquatic ecosystems have been set for the State, four connectivity classes and for thirteen connected water regions.

The regionalisation approach for each water type allows for increasingly specific guideline values for inland, estuarine, coastal and marine and ground water ecosystems.

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1. Introduction

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

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

The default guideline values presented in this guidance document and associated documents will inform the EPA Board WQO setting process.

1.1 National Context

The *National Water Quality Management Strategy* (NWQMS) forms part of the Council of Australian Government's (COAG) Water Reform Agenda and is the main mechanism for water quality management in Australia.

The main policy objective of the NWQMS is:

"to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development".

The strategy emphasises the importance of ecologically sustainable development, integrated catchment management, best management practices including the use of acceptable modern technology and waste minimisation and utilisation, and the role of economic measures including 'user-pays' and 'polluter-pays' approaches.

All are areas of focus in the State Policy and are captured within the *Environmental Management and Pollution Control Act 1994* (EMPCA).

Two previous guidance documents issued under the NWQMS are the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000) and the Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ, 2000). These were revised in 2018.

The current *Australian New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018) provides an authoritative guide for determining guideline values considered when setting water quality objectives to sustain current or likely future community (previously environmental) values for natural and semi-natural water resources in Australia and New Zealand. The ANZG 2018 recognise the interdependence of all aspects of aquatic ecosystems and different uses of water. Numerical values or descriptive statements for various indicators to guide the protection of aquatic ecosystems and human uses of waters (e.g. recreation, cultural and spiritual, drinking water, agriculture, and aquaculture) are available at a national level. Jurisdictional guideline values are also available to provide regional guidance where sufficient data exists.

A weight of evidence approach is applied in protecting the identified community values through an integrated assessment of biological condition, physical and chemical water quality, and sediment quality.

1.2 State Context

The principles and objectives for water quality management in Tasmania are provided in the *State Policy on Water Quality Management 1997 (SPWQM)*. It provides the management framework for the protection of water quality in Tasmania and provides for the implementation of the NWQMS in Tasmania. The State Policy provides a framework for the identification of protected environmental values (and uses) of water bodies, development of water quality guideline values and water quality objectives setting process, and the management and regulation of point and diffuse sources of emissions to surface waters and groundwater.

Under the State Policy the Protected Environmental Value (PEV) is defined as

"the value or use for which it has been determined a given area of the environment should be protected…".

Protected Environmental Values were set by the EPA Board (formerly the Board of Environmental Management and Pollution Control) for all of Tasmania's inland waterways and estuaries after community consultation. PEVs for coastal waters and groundwater have not been set by the EPA Board, except on a case-by-case basis. Proposed interim environmental values have been included though in these guidelines derived from guidance in the State Policy.

Possible environmental values to be protected are given in clause 7.1 of the State Policy, i.e.,

- protection of aquatic ecosystems
- recreational water quality and aesthetics
- raw water for town drinking water supply
- raw water for homestead supply
- agricultural water uses
- industrial water supply

To compare these PEVs to community values identified in the national guidelines, it is worth noting that the national guidelines define an agriculture environmental value as the 'Primary Industry' community value and includes irrigation, stock water and aquaculture. For the purposes of determining state default guideline values to be considered when setting water quality guidelines and objectives, consistent with the State Policy, irrigation and stock water will be under the agricultural water use PEV and the aquaculture under industrial water use PEV. In addition, the national guidelines include cultural and spiritual values, which are not identified as a PEV in the State Policy. It is however necessary that cultural and spiritual values be part of the discussion when determining water quality objectives.

One of the key objectives of the State Policy (Clause 6.1 (a)) is to "focus water quality management on the achievement of water quality objectives which will maintain or enhance water quality…." This approach is consistent with the national guidelines.

The setting of water quality objectives (WQOs) is a central component of the State Policy and WQOs provide the primary focus and reference point for the management of water quality and protecting the environmental values in Tasmania.

WQOs represent "the most stringent set of water quality guidelines that should be met to achieve all of the Protected Environmental Values" (Clause 9.1), and they are not to be used to set regulatory limits (Clause 9.3). WQOs become a metric of environmental management performance. Many of the strategies, actions, and outcomes outlined in Part 4 and the requirements of monitoring in Part 5 of the State Policy rely upon WQOs being set so as to measure success of the management of water pollution from point and diffuse sources (Clause 9.2).

The State Policy defines water quality guidelines as estimates, based on the best scientific information available, of the levels of indicators that should be met in order to protect an environmental value (Clause 8.1). They are a set of numerical concentrations or descriptive statements recommended for the support and maintenance of the designated water use or value, i.e. the protected environmental value (PEV). Water quality guidelines to protect human health should be those recommended by the National Health and Medical Research Council, unless specified by the Director of Public Health (Clause 8.2).

Guidelines to protect values other than human health are determined by the EPA Board on a case by case basis and based on site-specific information where available or in accordance with national guidelines.

The default guideline values presented in this guidance document and associated documents will inform the EPA Board WQO setting process.

1.3 Water Quality Objectives Setting Process

The Water Quality Objectives (WQO) setting process is consistent with the framework specified in the State Policy and the ANZG 2018.

Site-specific water quality guidelines and objectives are determined by the EPA Board. The default guideline values inform the EPA Board's deliberations in setting the WQOs. In brief the process is detailed below.

1. Identify the PEVs, which have been set for inland and estuarine waters, and proposed for marine (and coastal) waters and groundwater.
2. Define the water body, i.e., identify hydrological region down to catchment or sub-catchment level for freshwaters, the flushing characteristics for estuarine waters, provincial bioregions to meso-scale level down to coastal segment for marine waters, and connectivity class to connected region for groundwater.
3. Determine ecological condition of the water body, i.e. high ecological value ecosystems, slightly to moderately disturbed ecosystem, and highly disturbed ecosystems.
4. Determine the level of protection required for water body.
5. Identify the key indicators derived from known pollutants or environmental issues in water bodies; or suitable indicators of ecosystem health.
6. Use local data for physical and chemical stressors and biological condition and ensure sufficient data exists to underpin the statistical assessment of the data to determine GVs for aquatic ecosystems. Toxicant default guideline values from ANZG 2018 are used for generating DGVs unless site-specific ecotoxicity assessments have been conducted.
7. For other PEVs, refer to national guidelines for associated DGVs such as ANZG 2018 for primary industry water use, NHMRC Guidelines for managing risk in recreational water, and NHMRC Australian Drinking Water Guidelines for raw water for drinking.
8. When all the identified PEV DGVs have been determined use additional compiled data if available to determine site-specific GVs principally related to aquatic ecosystem protection.
9. Evaluate, review and update where necessary.
10. Select the most conservative GVs for the agreed PEVs as the proposed WQGs for a water body to derive WQOs for the EPA Board's deliberations in setting the WQOs. In most cases, this will be GVs for aquatic ecosystems.

1.4 Default Guideline Values

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

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

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

The primary focus within Tasmania has been the derivation of guideline values for Aquatic Ecosystems based on Tasmanian data for key indicators of interest. This is as the protection of aquatic ecosystems is a PEV common to all water bodies across all water types. In addition, the trigger values for aquatic ecosystems from the ANZECC 2000 water quality guidelines were based on either a very limited quantity of Tasmanian data or are based solely on data from other jurisdictions within the South-east zone. The trigger values were based on categorisation of Australia into four broad areas based on climate. (Figure 1.) The current ANZG 2018 are preparing fact sheets on physical and chemical stressors but recommends the use of local jurisdictional guideline values where available and provides reference to ANZECC 2000 were appropriate.

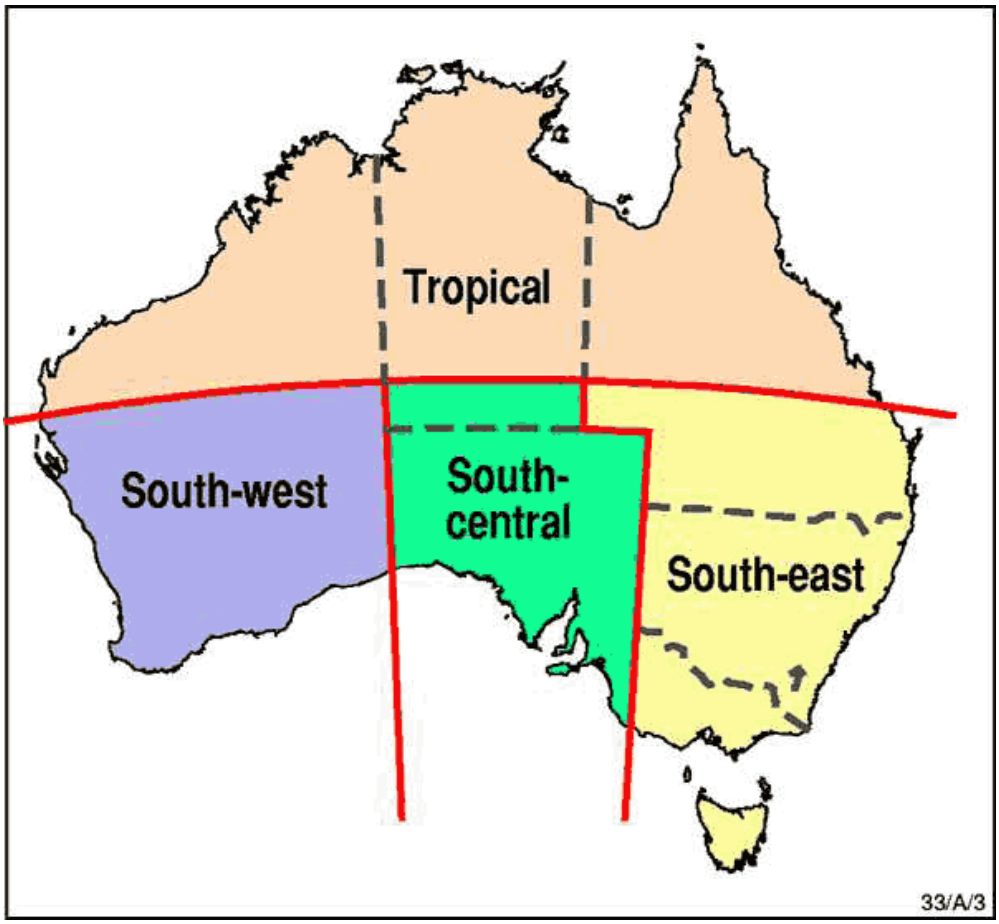


Figure 1. Climatic Zones of Australia (OzCoasts)

2. Regionalisation of Tasmania for DGVs for Aquatic Ecosystems

2.1 Introduction

Default Guideline Values (DGVs) for aquatic ecosystems were developed at the State, region and sub regional levels for the water types of fresh, estuarine and marine and for groundwater.

Regionalisation represents a spatial classification for each water type based on ecology and geography and is a critical component of the process for deriving State, regional and sub-regional guidelines and assisting the setting of ecosystem based management goals (Figure 2).

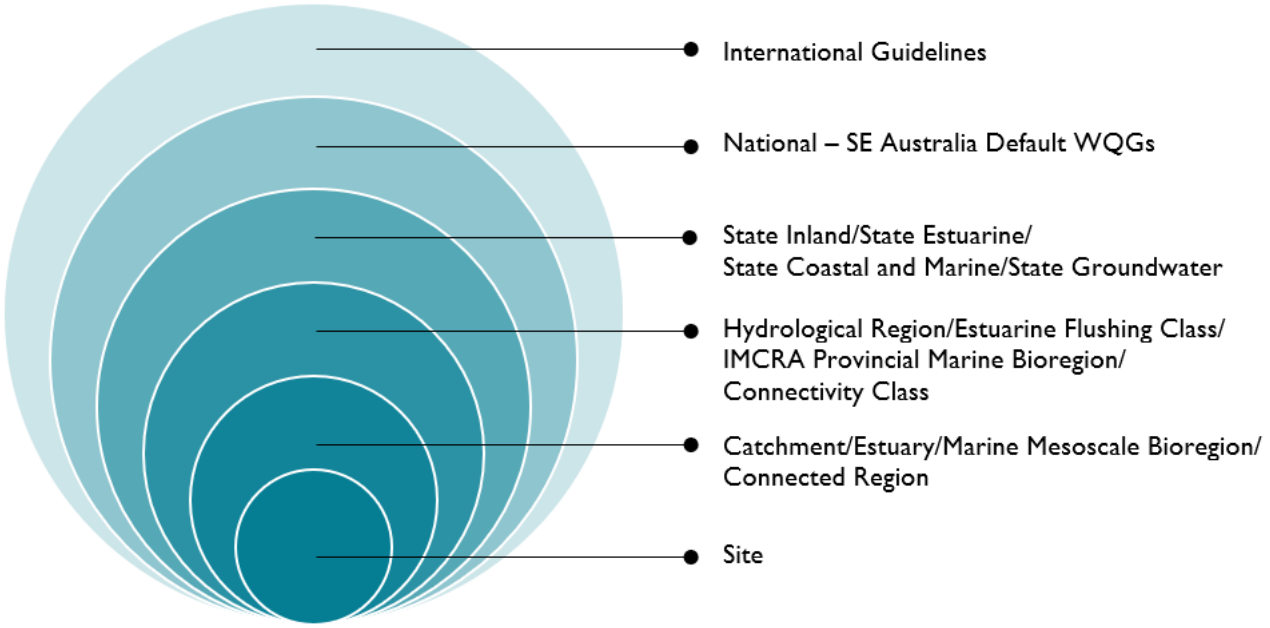


Figure 2. Decision Framework for deriving DGVs for aquatic ecosystems

2.2 Freshwater

Tasmania forms a single topographic drainage division (Drainage Division 3). To further refine this, a hydrological regionalisation approach has been adopted that is based on river flow information (Hughes, 1987). This work showed that there are four hydrologically distinct regions across the State. The hydrologically distinct groupings (Figure 3) are largely determined by the characteristics outlined in Table 1. There are 48 individual surface water catchments within Tasmania, containing 1,160 sub catchments, over 361,000 river sections and around 1350 standing waterbodies.

Freshwater DGVs for aquatic ecosystems have been derived for:

- The entire state,
- Each of the four hydrological regions,
- Each of the 48 surface water catchments.

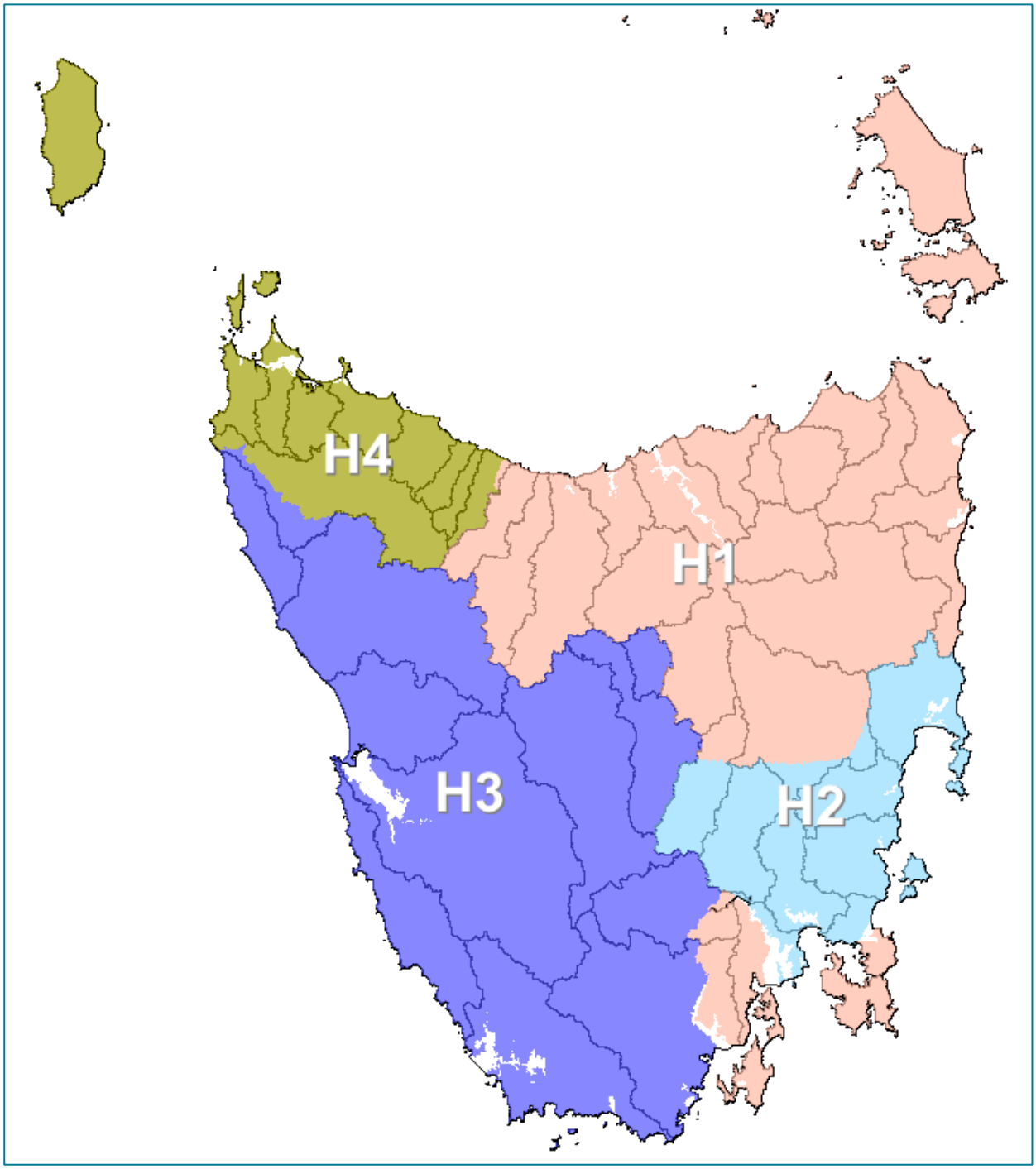


Figure 3. Hydrological regions (Hughes, 1987) and topographic catchments

Table 1. Hydrological Regions in Tasmania

Hydrological Grouping	Descriptor (Hughes, 1987)
H1	Streams located inland from Tasmania's northern coast (including north east) characterised by moderately high runoff (762 mm), low CV annual flow and skewness (0.36 and 0.15, respectively), moderate to low CVs of monthly and monthly maximum flows (0.65 and 0.54, respectively) but high variability in low flows (CV = 0.91).
H2	Streams in the south-east corner of Tasmania characterised by low runoff (142 mm), high CV of annual flow (0.87), high skewness of annual flows (1.04) and high CVs of annual (0.87), monthly (0.70), maximum (0.67) and minimum flows (1.14).
H3	Streams in the south west Tasmania characterised by high runoff (1347 mm), very low CV of annual flow (0.23) and low skewness (0.46) and low CVs of monthly (0.49), maximum (0.44) and minimum (0.67) flows.
H4	Streams typically located on the north-western coastal zone of Tasmania. intermediate runoff values (mean = 410 mm), moderate CV of annual flows (0.52), moderate skewness of annual flows (0.75), comparatively high CVs of monthly (0.75), maximum (0.66) and minimum (1.19) flows , low variability of peak flows (0.29) but high variability of low flows (0.66).

Where CV is the coefficient of variability.

DGVs have not been derived for inland standing waterbodies. GVs are being prepared on an as needs basis for individual lakes and impoundments. In the interim the default trigger values provided for South East Australia should be referred to.

DGVs have not been derived for wetlands. As with lakes and impoundments these will be produced on an as needs basis. Unlike lakes and impoundments there are no default trigger values for wetlands available for South East Australia.

Toxicant information can be applied, and professional judgment will be necessary for deriving GVs for key indicators. However, toxicant default guideline values with high, moderate or unknown (low) reliability are available from Australian Government water quality website.

2.3 Estuarine waters

Regionalisation of estuaries is based on the ability of an estuary to exchange water from freshwater to marine waters, known as the flushing time.

All estuaries have been assigned to a flushing class using the approach developed under the Landscape Logic program by the University of Tasmania (UTAS).

Three classes of estuary were identified based on key hydrological influences (river flow and tidal range) and physical characteristics (volume and entrance geomorphology), which determine the flushing time (Figure 4).

The classes of estuary identified are

- Well Flushed
- Poorly Flushed
- Open/Closed

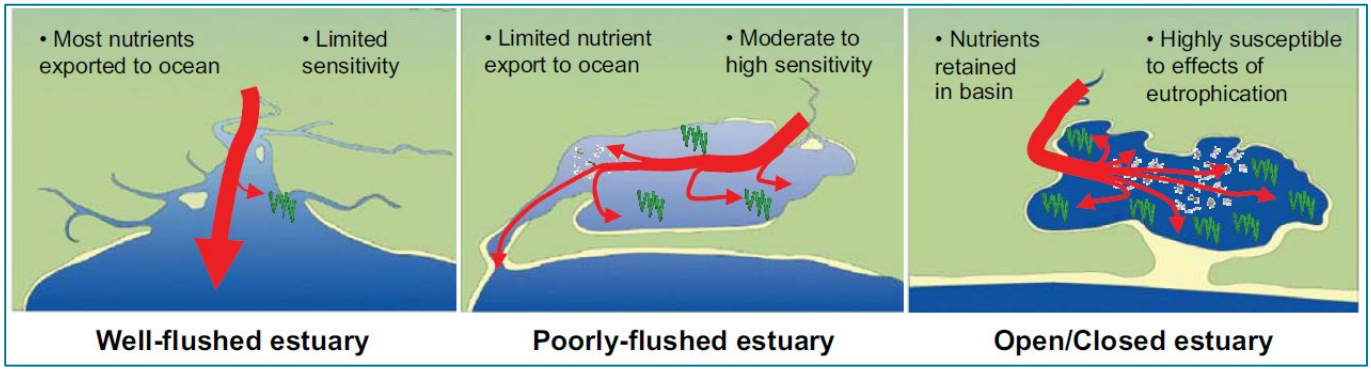


Figure 4. Estuary classes (image from Landscape Logic)

The susceptibility of each of these classes to degradation from eutrophication is linked to the ability to flush out pollutants. The variation between the estuary classes results in each class being susceptible to different critical events. Location within an estuary, i.e. upper, middle and lower locations, has also been found to play a significant role in susceptibility to water quality perturbations (Figure 5).

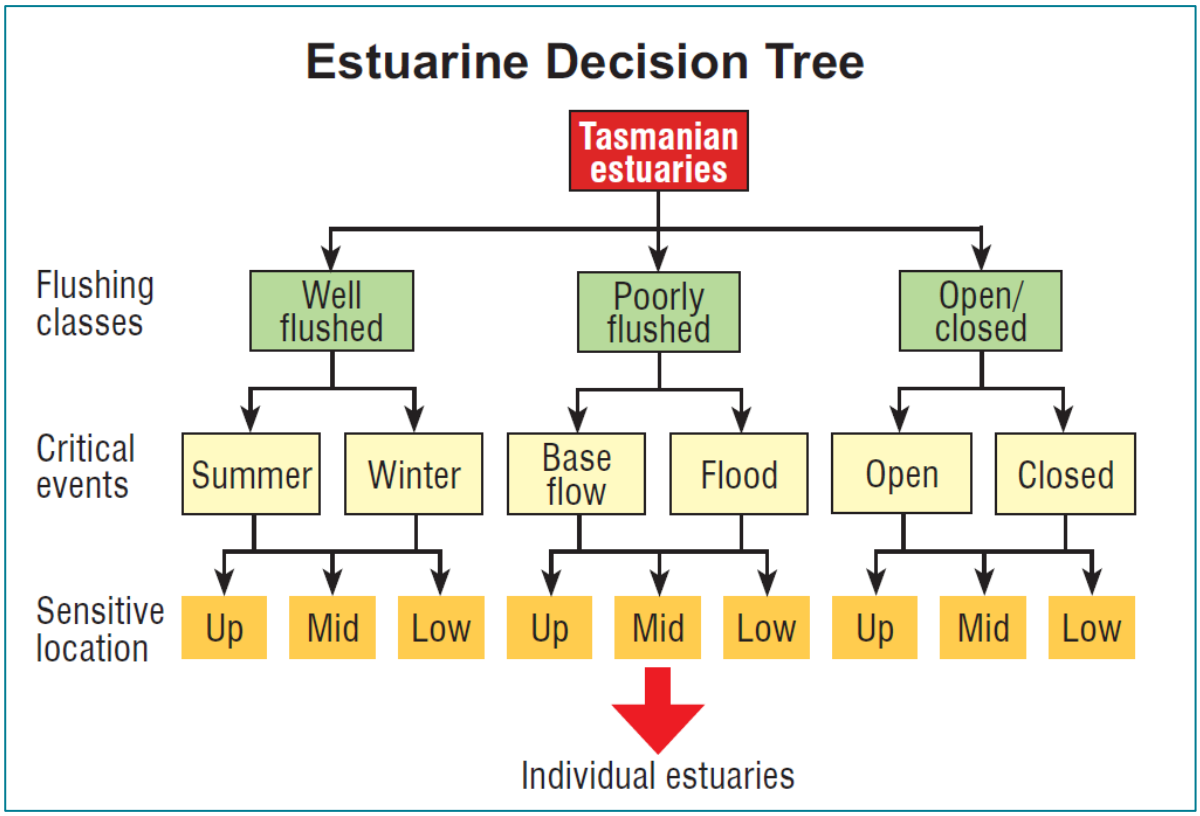


Figure 5. Estuarine decision tree for Tasmanian estuaries (image from Landscape Logic)

The decision tree will support management of estuaries by providing a standardised means of condition assessment and interpretation of information.

Estuarine DGVs for Aquatic ecosystems have been derived for

- The entire state,
- Each of the three Flushing classes,
- Each of the Critical event.
- Sensitive location (where sufficient data is available)

2.4 Coastal and Marine waters

The Australian Government's marine bioregion planning process defined Tasmania as belonging to the South-East Marine region. The region includes waters governed by South Australia, Victoria, New South Wales and Australian governments. The incorporation of regionalisation based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA 4.0) and the Tasmanian Oil Spill Response Atlas has permitted a finer scale of regionalisation.

2.4.1 IMCRA 4.0

IMCRA 4.0 is a spatial framework for classifying Australia's coasts and near shore marine environment into bioregions. It is derived from biological and physical data, including the distribution of demersal fishes, marine plants and invertebrates, sea floor geomorphology and sediments, and oceanographic data. It allows for the refinement of the coarse marine bioregions into more appropriate bioregions that are relevant to the state. There are two levels of regionalisation, the less specific being the Provincial Bioregion and the finer being the Mesoscale bioregion. There are four Provincial bioregions around Tasmania in which nine Mesoscale bioregions are nested (Figure 6).

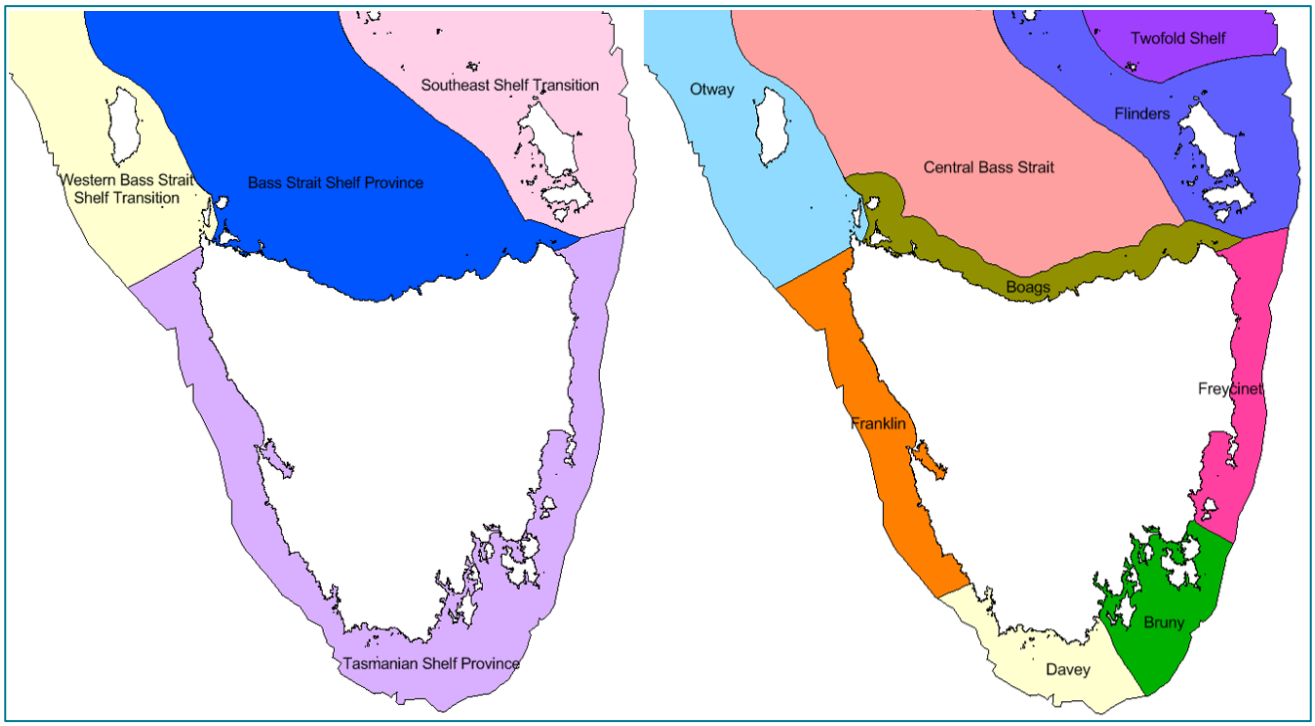


Figure 6. Provincial (left) and Mesoscale bioregions (right) of Tasmania

2.4.2 OSRA

The IMCRA framework has been further refined through the Oil Spill Response Atlas (OSRA) Marine Ecological Prioritisation Project (MEPP), which categorically prioritised and mapped marine natural values for 20 km segments of the Tasmanian coastline. The MEPP prioritised natural values on the basis of conservation significance, with no reference to anthropogenic uses.

The MEPP developed a base map for the Tasmanian coastline by allocating 20 km coastal segments that were arranged orthogonally to the coast (i.e. compliant with coastal features and shape) and mapped at a scale of 1:25,000 (Figure 7). The aim was to select a segment size and type which provided an appropriate level of spatial resolution for the purpose of planning activities and resulted in relatively even segment sizes to avoid biases associated with aerial coverage.

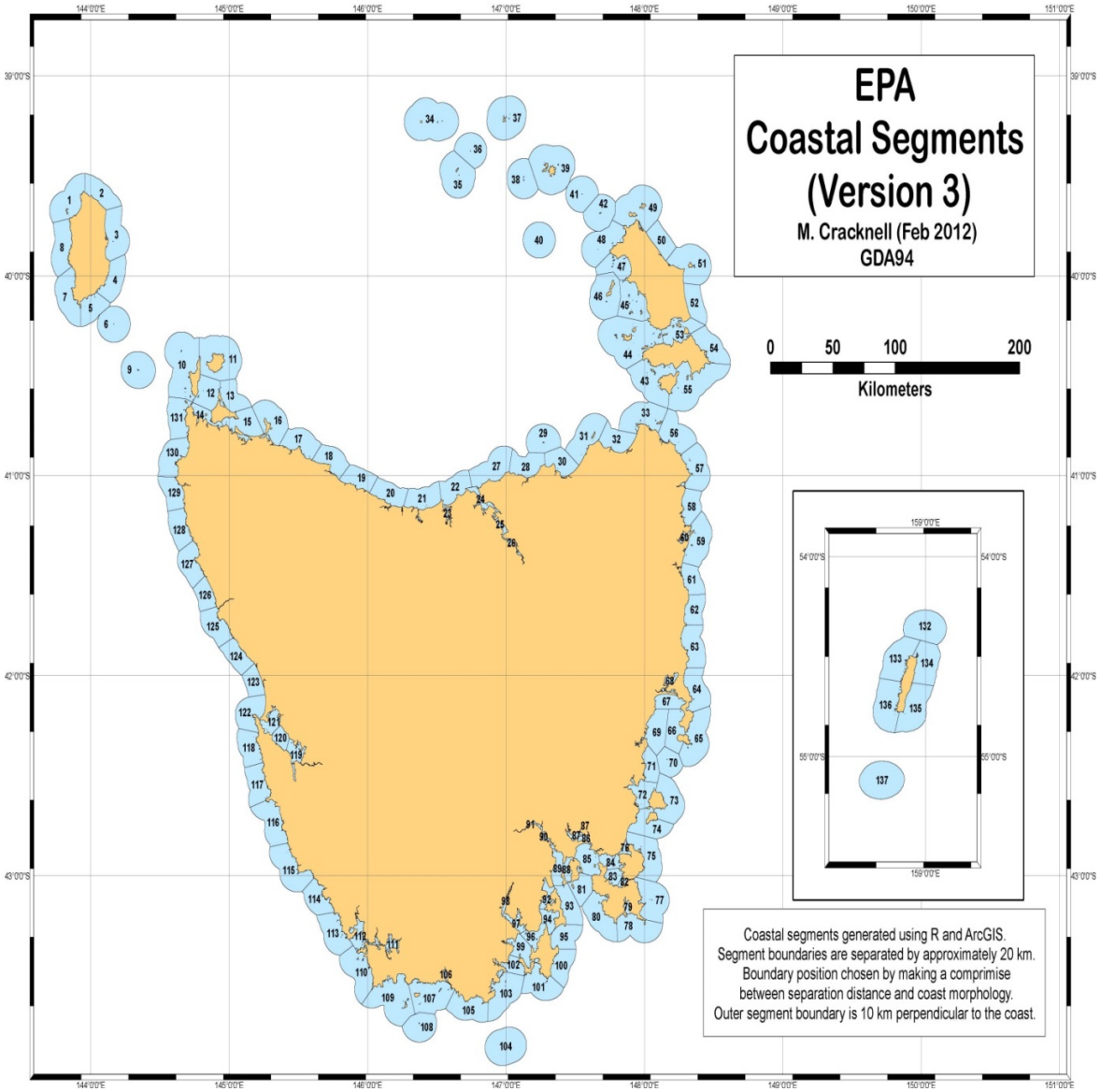


Figure 7. OSRA Coastal segments

Coastal and Marine DGVs for Aquatic ecosystems have been derived for

- The entire State
- Each of the Provincial Bioregions
- Each of the Mesoscale Bioregions
- OSRA Region (where sufficient data is available)

2.4 Ground Water

Regionalisation incorporates knowledge on surface water, hydrogeological and physiographic regions.

The State coverage and level of groundwater and surface water connectivity is outlined in Figure 8 and the connected water regions in Figure 9. The four connectivity classes provide a practical means of providing a broader grouping for the connected water regions as outlined in Table 2.

Interim DGVs for aquatic ecosystems of groundwater of Tasmania have been derived for the entire State, each connectivity class and each connected region. The interim DGVs are based on the degree of connectivity between groundwater and surface water. Connectivity refers to the direction and magnitude of flow between water located above and below ground. Factors such as topography, geology and climate can change the direction and magnitude of these flows.

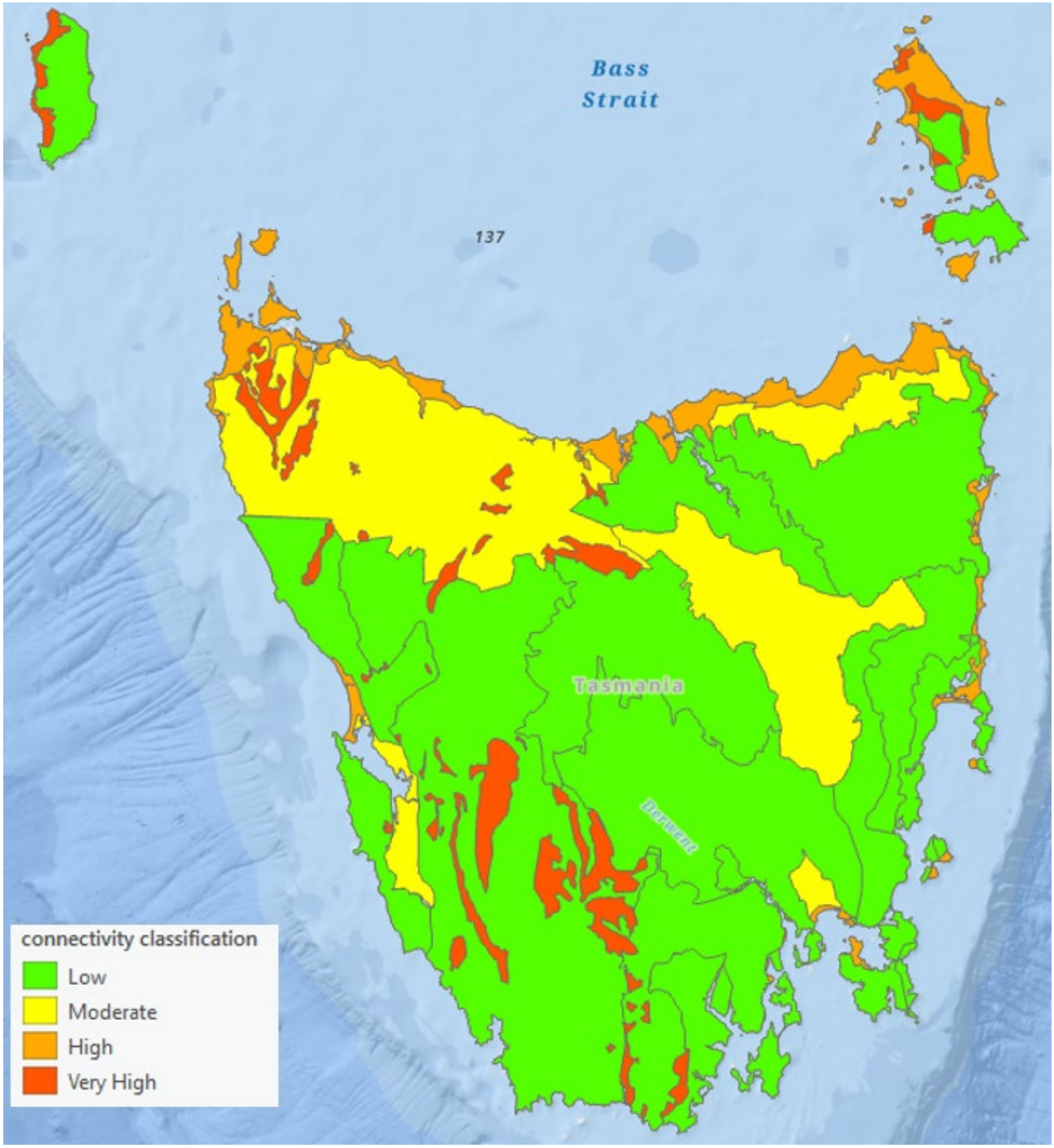


Figure 8. Tasmanian connectivity classification (Sheldon, 2011)

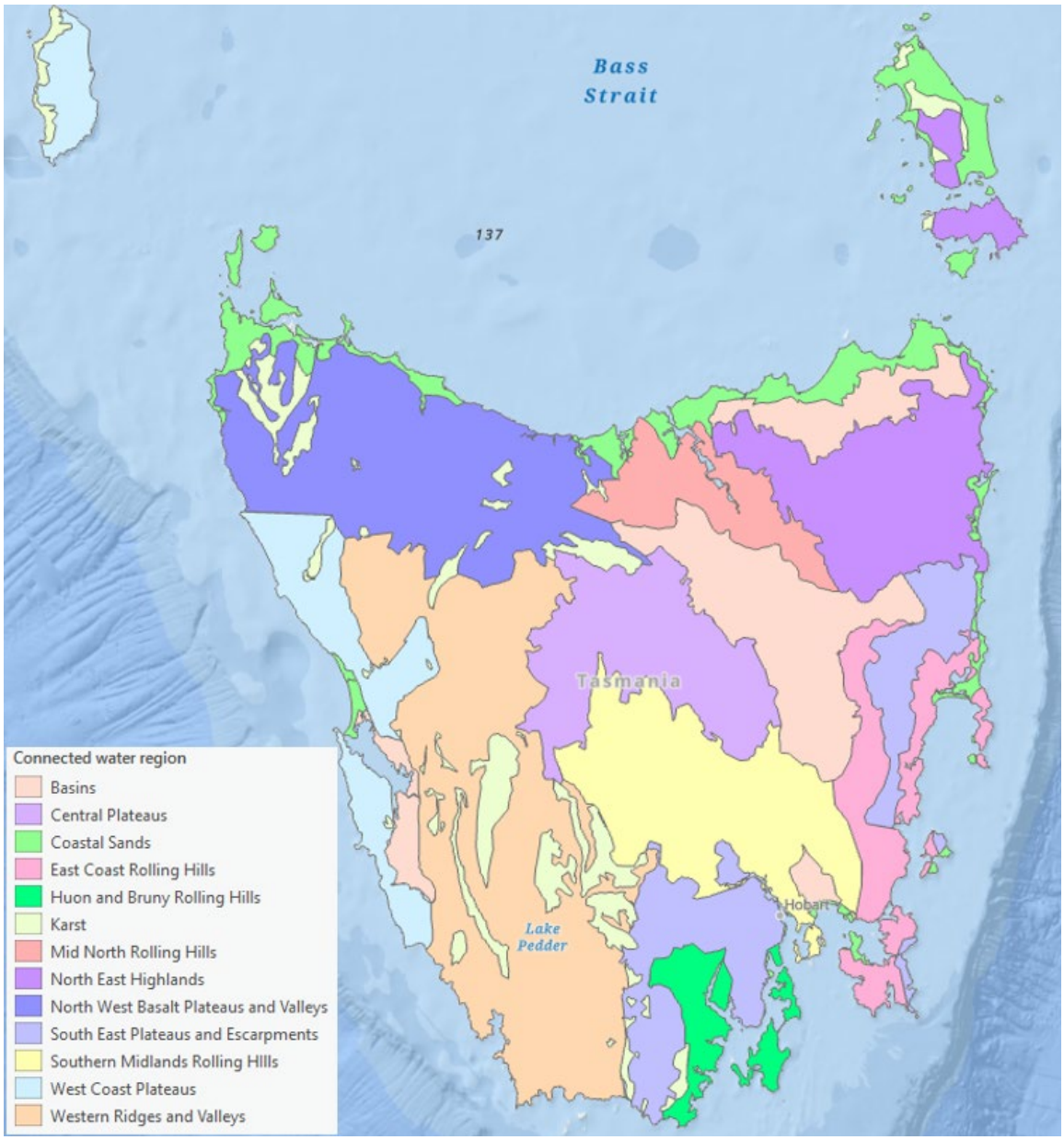


Figure 9. Tasmanian connected water regions, Sheldon (2011)

Table 2. Groundwater connectivity classes and associated connected water regions

Connectivity classification	Descriptor	Connected Water Region
Low	Non basalt fractured rock aquifers	Huon and Bruny Rolling Hills, East Coast Rolling Hills, North East Highlands, Southern Midland Rolling Hills, South East Plateaus and Escarpments, Central Plateaus, West Coast Plateaus, Western Ridges and Valleys, and Mid North Rolling Hills
Moderate	Alluvial basins and basalt fracture rock aquifers	North West Basalt Plateaus and Valleys, and Basins
High	Sand aquifers	Coastal Sands
Very High	Conduit aquifers	Karst

3. Ecosystem Condition and Level of Protection

Ecosystem condition is a reflection of the departure of an ecosystem for natural or pre-European condition. The level of protection provided to an ecosystem is associated with the management goal to maintain and/or enhance water quality. It is a level of protection identified or "expected" through identified community values or Protected Environmental Values (PEVs). Ecosystem condition and level of protection and responses of indicators are considered when determining management goals and water quality objectives.

3.1 Ecosystem Condition

The ANZG 2018 provides a framework for developing water quality guideline values based on the water type, health of aquatic ecosystems or ecosystem condition. Ecosystem condition can be viewed as a continuum ranging from natural to highly disturbed or artificial. The ANZG 2018 identifies three broad categories of ecosystem: High Ecological Value (HEV), Slightly to Moderately Disturbed (SMD) and Highly Disturbed (HD). To better characterise Tasmanian ecosystems the SMD category has been further divided into Slightly Modified Ecological Value (SMEV) and Moderately Disturbed (MD) (Figure 10).

3.1.1 High Ecological Value Ecosystems

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

3.1.2 Slightly to Moderately Disturbed Ecosystems

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

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

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

3.1.3 Highly Disturbed Ecosystem

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

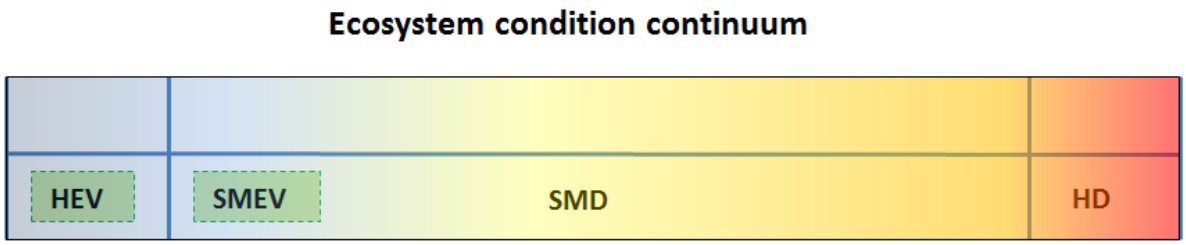


Figure 10. Ecosystem condition continuum showing HEV and SMEV reference categories

3.3 Determining Ecological Condition

A broad range of resources were used to assign ecosystem condition to individual locations and to water bodies more broadly. These Resources include:

- Tasmanian Vegetation Project (by DPIPWE)
- Conservation of Freshwater Ecosystems Values (CFEV) Project (by DPIPWE)
- Coastal and Estuarine Resource Condition Assessment Project
- Landscape Logic program by University of Tasmania (UTAS)
- Water Information Management System (WIMS) database
- National Pollution Inventory NPI database
- Oils Spill Response Atlas (OSRA) database
- Mine site database held by Mineral Resources of Tasmania
- Aerial images – e.g. Google Earth
- Expert opinion

These resources provide information on the following:

- The degree of catchment disturbance (through such activities as agriculture, forestry, mining and aquaculture)
- Riparian vegetation condition
- Degree of urbanisation within a catchment
- Perturbations to flow regime by abstraction or regulation
- Disturbance to hydrological connectivity from weirs or dams for irrigation or power generation
- Flushing characteristics of estuaries
- Sensitivity of water bodies to human induced changes
- Location of point source discharges (such as sewage treatment plant and industrial outfalls)
- Potential for occurrence of diffuse source inputs (such as urban and agricultural runoff)

3.4 Level of Protection

The level of protection is associated with the management goal to maintain or improve water quality, which is consistent with an objective of the State Policy maintain or enhance water quality. Water quality targets (i.e., intermediate water quality objectives) can be set for progressively improving water quality.

The water quality objectives may be derived from default guideline values recommended for the particular ecosystem condition and percent of species protection, or they may represent, using site specific data, an acceptable level of change from a defined improved reference condition. For example, maintaining the current water quality to support a moderately disturbed ecosystem as distinct from setting WQOs for improving water quality to support a less impacted ecosystem.

The level of protection for the three principle ecosystem conditions are described below.

- For high ecological values ecosystems the goal is for the indicators of biological diversity to not change markedly. Any management action should be considered with any apparent trend away from a baseline, or once an agreed threshold has been reached. Any decision to relax the physical and chemical WQG values for HEV ecosystems is only made if it is known that such degradation in water quality will not compromise the objective of maintaining biological diversity in the system.

The nature of contaminants expected in the receiving waters affects decisions around any assessments. Where there is minimal biological assessment data for the system, the management objective should be to

ensure no change in the concentrations of the physical and chemical water quality indicators beyond natural variation.

- For slightly to moderately disturbed ecosystems some relaxation of the stringent management approach used for HEV ecosystems is possible but, similarly, the goal is maintenance of biological diversity relative to a suitable reference condition. For moderately disturbed ecosystems improving water quality will be dependent on whether aspirational water quality targets have been determined as part of the stakeholder consultation process.
- For highly disturbed ecosystems the management goal would be to retain a functional ecosystem. Stakeholder consultation is particularly important when the management goal is improvement and the setting of more aspirational water quality targets is required.

The national guidelines use risk-based decision trees to consider ecosystem-specific modifying factors (such as pH, salinity, hardness, suspended particulates and temperature), bioavailability, and bioaccumulating potential.

The default toxicant guideline values provided are calculated to protect a pre-determined percentage of species. For slightly to moderately disturbed systems, toxicant values are provided for 95% protection of species (with a 50% confidence level). For pristine areas and bioaccumulating toxicants, values are provided for 99% protection of species, and for highly disturbed ecosystems the 80% protection level is provided, however 95% protection of species would be aspirational water quality targets for such disturbed systems.

3.5 Protected Environmental Values – Community Values

A primary step in the implementation of the State Policy was the identification of Protected Environmental Values (PEVs) for surface waters. PEVs are the values or uses of the water body for which it is determined that any given area of that water body should be protected.

The State Policy specifies a range of PEVs (Clause 7.1) which may be applied to a given water body with more than one PEV generally applying. The PEVs that are applicable and considered in a community consultation process are as follows:

- protection of aquatic ecosystems
  - surface waters including estuaries (but not coastal waters)
  - coastal waters
  - groundwater;
- recreational water quality and aesthetics
  - primary contact
  - secondary contact
  - aesthetic;
- raw water for town drinking water supply
- raw water for homestead supply
- agricultural water uses
  - irrigation
  - stock water
- industrial water supply (including aquaculture)

3.5.1 Inland Waters

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

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

A: Protection of Aquatic Ecosystems

(i) Pristine or nearly pristine ecosystems

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

OR

(ii) Modified (not pristine) ecosystems

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

OR

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

B. Recreational Water Quality & Aesthetics

(i) Primary contact water quality (specify sites)
(ii) Secondary contact water quality
(iii) Aesthetic water quality

C. Raw Water for Drinking Water Supply

(i) Subject to coarse screening plus disinfection

D. Agricultural Water Uses

(i) Irrigation
(ii) Stock watering

E. Industrial Water Supply

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

3.5.2 Estuarine Waters

PEVS for estuarine waters were determined through extensive stakeholder consultation and identification of community values and uses.

An example of the currents PEVs for estuarine waters is as follows:

A: Protection of Aquatic Ecosystems

(i) Pristine or nearly pristine ecosystems

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

OR

(a) Modified (not pristine) ecosystems

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

OR

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

B: Recreational Water Quality & Aesthetics

(i) Primary contact water quality

(ii) Secondary contact water quality

(iii) Aesthetic water quality

C: Industrial Water Supply (Selected areas of aquaculture in Marine Farming Zones)

That is, as a minimum, water quality management strategies should seek to provide water of a physical and chemical nature to support a pristine/modified ecosystem from which edible fish, shellfish and crustacea are harvested; which will allow people to safely engage in recreation activities such as swimming, paddling or fishing in aesthetically pleasing waters; and which is suitable for the farming of shellfish in marine farming zones.

3.5.3 Coastal and Marine Waters

PEVs have not yet been set at a State level for coastal and marine waters, however, interim PEVs have been determined. The proposed interim PEVs for coastal and marine waters are:

A: Protection of Aquatic Ecosystems

(i) Coastal waters ecosystems

B: Recreational Water Quality & Aesthetics

(i) Primary contact water quality

(ii) Secondary contact water quality

(iii) Aesthetic water quality

C: Industrial Water Supply (Selected areas of aquaculture in Marine Farming Zones)

That is, as a minimum, water quality management strategies would seek to provide water of a physical and chemical nature to support coastal ecosystems (either pristine or modified) from which edible fish, shellfish and crustacea are harvested; which will allow people to safely engage in recreation activities such as swimming, paddling or fishing in aesthetically pleasing waters; suitable for the farming of shellfish in marine farming zones; and suitable for use as industrial water supplies (including for intensive aquaculture).

3.5.4 Groundwater

PEVs have not yet been set at a State level for groundwater at the date of publication of these guidelines.

The PEVS for groundwater could be determined on the basis of current uses and values consistent with the process used for surface waters. However, there is a paucity of knowledge around this and the complexity of connectivity between groundwater and surface waters means interim PEVS could alternatively be proposed on the basis of potential use until better scientific information is available.

The proposed interim PEVs likely to be possible, given a level of total dissolved solids (detailed below and in the State Policy), for groundwater are:

A. Protection of Aquatic Ecosystems

(i) Groundwater ecosystems

B: Recreational Water Quality & Aesthetics

(i) Primary contact water quality (specify sites – e.g. karst systems)
(ii) Secondary contact water quality
(iii) Aesthetic water quality

C: Raw Water for Drinking Water Supply

D: Raw water for homestead supply (Subject to coarse screening plus disinfection)

E: Agricultural Water Uses

(i) Irrigation
(ii) Stock watering

F: Industrial Water Supply (Selected areas that have land based commercialised aquaculture)

That is, as a minimum, water quality management strategies should, where groundwater has TDS levels below 500 mg/L, maintain below these levels wherever practicable and seek to provide water of a physical and chemical nature to support a healthy aquatic ecosystem; that is suitable as a raw water for drinking water supply subject to coarse screening plus disinfection at the points of extraction (if TDS<1000mg/L); that is acceptable for irrigation (if TDS is <1000-3500mg/L; affected by crop salt tolerance) and stock watering purposes (if TDS <3500-13000mg/L; affected by animal species salt tolerance); which will allow people to safely engage in primary contact recreation activities such as body immersion at specific karst system sites and secondary contact recreation activities in aesthetically pleasing waters; and which is suitable for industrial waters such as terrestrial based aquaculture at specific locations.

4. Indicator Values for Environmental Values

The selection of indicators that can best assess to what extent a community value (i.e., PEV) and thus the ecosystem is being protected is paramount. A guiding principle is to determine those indicators most relevant to the community values of interest for a given water type. Key indicators for particular protected environmental values may be unique so the corresponding WQG would become the specific WQO. Other indicators may be common to several environmental values which require a selection process of the most conservative WQGs to determine the WQOs.

The following sections outline the key indicators and/or those that bear consideration for each group of environmental values.

4.1 Aquatic Ecosystem Protection

To protect aquatic ecosystems from degradation a range of physical, chemical and biological indicators need to be monitored and WQGs set. Default trigger physical and chemical (PC) values have been derived for

South East Australia through the ANZG 2018 to assess risk of adverse effects due to nutrients, biodegradable organic matter and pH in various ecosystems types. However, regional and sub-regional trigger values have been derived for the PC stressor indicators of pH, electrical conductivity, total suspended solids, temperature, dissolved oxygen, Chlorophyll a, total phosphorous, dissolved reactive phosphorous, total nitrogen, nitrate and nitrite, and ammonia. The ANZG 2018 identifies the use of multiple lines of evidence for ecosystem protection.

In addition to PC stressors, biological and sediment indicators can be included where data is available and statistically robust. Due to the paucity of accessible sediment data across Tasmania, regional sediment quality guideline values have not been derived, so the National Sediment Quality Guidelines will be used as default values which is particularly relevant when considering sediment toxicity.

Similarly, guidelines for biological stressors have not been derived for estuarine and coastal and marine waters. A framework for deriving indicators for estuarine and coastal and marine water types is provided in a the publication Users' Guide for Estuarine, Coastal and Marine Indicators for Regional NRM Monitoring. Section 5.3 of that document details the physical and chemical stressors, along with biological stressors for which DGVs for aquatic ecosystems have been derived for each water type for Tasmania.

4.2 Recreational Waters

To protect water bodies for recreational activities such as swimming, boating and aesthetic appeal a range of physical, chemical and microbiological characteristics need to be monitored and WQGs set.

The indicators include pH, temperature, natural visual clarity, colour, oil and grease (including petroleum hydrocarbons), debris, toxic chemicals (either toxic or irritating to the skin), algae (Macrophytes, phytoplankton scums, filamentous algal mats, and sewage fungus), enterococci, and cyanobacteria (e.g. for freshwater, *Mycrocystis sp.* and *anabaena sp.* as well as the associated microtoxins, such as microcystin and saxotoxin).

For more details on key indicators and associated guideline values refer to the Guidelines for managing risks in recreational waters and Appendix G.

4.3 Agricultural/Primary Industry

Under the State Policy the PEVs for 'agricultural water uses' are applicable to irrigation and stock water, and 'industrial water supply' to aquaculture. These are analogous with the 'Primary Industry' environmental value in ANZG 2018.

Irrigation and livestock watering are the major agricultural uses of water and a range of indicators and associated guideline values are detailed in the ANZG 2018. There are many factors that influence the suitability of water for crop production or livestock watering, including difference requirements between plant and animal species and different stages of growth and importantly in the case of animals their general health condition (and their suitability as a food for human consumption) and even physiologically whether they are mono-gastric and ruminant animals.

When considering key indicators there are long term and short term trigger/guideline values and the potential soil accumulative contaminant loading limit that need to be considered with the refinement of how the indicators are to be applied. Some of the key indicators are detailed below (Table 3).

Table 3. Key indicators for Irrigation and Stock Water

Irrigation Water	Stock Water
Salinity (or EC)	Salinity (or EC)
pH	pH
Sodium	Sodium
Calcium	Calcium
Magnesium	Magnesium
Chloride	Nitrate

Irrigation Water	Stock Water
Phosphorus	Nitrite
Nitrogen	Sulphate
	Total Dissolved Salts
	Metals
Metalloids	Metalloids
Organic contaminants (e.g. pesticides)	Organic contaminants (e.g. pesticides)
Cyanobacteria	Cyanobacteria
Thermotolerant Coliforms	Thermotolerant Coliforms
Plant Pathogens	Animal Pathogens

The key indicators for aquaculture, as for livestock, are related to animal health, and as a food for human consumption. While the indicators are relevant to commercial and recreational fisheries the guideline values for aquaculture are for protecting commercial fish species produced in intensive husbandry systems such as terrestrial based aquaculture or penned fish in open water. As wild fish stocks are dependent on healthy ecosystems for their entire life cycle they are best protected by the guideline values as part of the protection of aquatic ecosystem environmental value.

As information on contaminant accumulation is a public health issue and particularly limited for aquaculture species the selection of key indicators to address potential contaminant accumulation or concerns for protecting human consumers should be through the ANZG 2018 in conjunction with the Food Standards Code, Australia New Zealand Food Authority, 1996, or updates.

Some key physico-chemical indicators that can adversely affect aquaculture operations include alkalinity, biochemical oxygen demand (BOD), chemical oxygen demand (COD), carbon dioxide, colour and appearance of water, dissolved oxygen and gas super-saturation, alkalinity/hardness ($CaCO_3$), pH, salinity (total dissolved solids) and suspended solids.

For fish health and as a food for human consumption there are some other categories of stressors that should to be considered. These are outlined in Table 4 below.

Table 4. Fish Health Stressors

Stressor Categories	Stressor Examples
Inorganic toxicants	metals
Organic toxicants	hydrocarbons
	pesticides
Biological contaminants	bacteria (e.g. thermotolerant coliforms)
	viruses
	parasites
Marine bio-toxins	paralytic shellfish poisoning (PSP),
	diarrhetic shellfish poisoning (DSP)
	amnesic shellfish poisoning (ASP)
Off-flavour compounds (tainting substances)	Phenolic compounds

4.4 Drinking Water

The Australian Drinking Water Guidelines (ADWG) are intended to meet the needs of consumers and apply at the point of use, i.e. at the tap. They are applicable to any water intended for drinking irrespective of its source (municipal supplies, rainwater tanks, bores, point-of-use treatment devices, etc.) or where it is used (the home, farmstead water supplies for domestic use, restaurants, camping areas, shops, etc.).

The ADWG provide an authoritative Australian reference on good drinking water quality, covering a wide range of the microbiological, physical, chemical and radiological characteristics that determine water quality. They fall into the following categories for identifying key indicators:

- Microorganisms: including bacteria, protozoa, toxic algae, and viruses;
- physical characteristics;
- radionuclides; and,
- chemicals, including inorganic chemicals, organic compounds, organic disinfection by-products, and pesticides.

Several "guideline" values may be provided with each key indicator so it is necessary to select the most stringent for the protection of public health in the context of protecting the "raw water for drinking water purposes" environmental value. The guideline values provided include:

- A **health-related guideline value, which** is the concentration or measure of a water quality characteristic that, based on present knowledge, does not pose any significant risk to the health of the consumer over a lifetime of consumption.
- An **aesthetic guideline value, which** is the concentration or measure of a water quality characteristic associated with good quality water.
- a **guideline (numerical or descriptive) value**, intended for use by regulatory authorities for surveillance and enforcement purposes
- **a health (numerical) value**, intended for use by health authorities when managing health risks associated with inadvertent exposure such as from a spill or misuse of a pesticide.

4.5 Cultural and Spiritual

Indigenous cultural and spiritual (C&S) values relate to a range of uses and issues such as spiritual relationships, significant sites in the landscape, customary use, plants and animals associated with water, drinking water and recreational water. These values and associated key indicators are in part integrated to the other PEVS identified but others are not. As Indigenous knowledge spans identification of bio-indicators, significance and types of environmental flow, Indigenous seasonal calendar and water cycle management it is necessary for consultation to take place with Indigenous elders and communities within the State. Through dialogue it will be possible to identify common key indicators between C&S values other PEVS and possibly identify other key indicators which are relevant to C&S values not covered by the other PEVs. The national guidelines for the cultural and spiritual values of waterways provide an overview of values that are pertinent to Tasmania.

4.6 Industrial

While no specific key indicators or associated guidelines are presented for different industry types in these guidelines, the recommended approach is to identify any major industries potentially sourcing the water for an industrial purposes, consult with representatives of the specific industries or possibly the industry groups and determine the key indicators and associated water quality requirements. Generally, though industrial water requirements are so varied (both within and between industries) that individual industry consultation would mostly likely be necessary. These industry specific guideline values would then be considered in the selection process of determining the most stringent guideline values for the identified key indicator to determine the WQO.

Generally, sources of water for industry often coincide with other identified protected environmental values. These other PEVs, particularly the protection of aquatic ecosystems, tend to drive the management of the resource because of more stringent requirements.

5. Deriving DGVs for Aquatic Ecosystems

The primary focus within Tasmania has been the derivation of guideline values for Aquatic Ecosystems based on Tasmanian data for key indicators of interest.

Guideline values for aquatic ecosystems have been generated from site-specific data based on the water type and region (as outlined in Section 2) and ecosystem condition (as outlined in Section 3).

5.1 Site information data

5.1.1 Data Sources

Site specific data was sought and collected from a range of sources,

- Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- Cradle Coast NRM
- Derwent Estuary Program (and associated partners)
- Forestry Tasmania
- Hydro Tasmania
- Institute for Marine and Antarctic Studies (IMAS)
- Marine Farming Branch, Department of Primary Industries, Parks, Water and Environment
- NRM North
- Tamar Estuary and Esk Rivers Program (and associated partners)
- Tasmanian Shellfish Quality Assurance, Department of Health and Human Services (DHHS)
- Water Assessment Branch, Department of Primary Industries, Parks, Water and Environment
- Mineral Resources Tasmania

5.1.2 Sites and Water Type

All sites were assigned to the appropriate water type and to a specific waterbody on the basis of spatial information provided by the data provider.

Sites in inland waters

The location of all inland water sites was verified in GDA94. In some instances, the same location was monitored by multiple organisations or under many projects by a single organisation. Under such instances the location became a single site with monitoring data differentiated on the basis of project. The assignment to a river section or water body was based on information from the Conservation of Freshwater Ecosystems Values (CFEV) Project. The linking of a site to a physical river section or water body allowed for the site to be assigned to a sub-catchment, catchment and hydrological region as detailed in Table 5.

Table 5. Hydrological region and associated catchments

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

Sites in estuarine waters

In some instances, the same location was monitored by multiple organisations or under many projects by a single organisation. Under such instances the location became a single site with monitoring data differentiated on the basis of project. The assignment to an individual estuary was based on information from the Conservation of Freshwater Ecosystems Values (CFEV) Project. The linking of a site to an estuary allowed for the site to be assigned not only to the individual estuary but to a known flushing class. Sites were ultimately assigned to either the lower, middle or upper estuary. The flushing class of the 113 Estuaries within the CFEV estuary dataset are detailed in Table 6 below.

Table 6. Flushing Classes and associated estuaries

Flushing Class	Estuary
Well Flushed	The Mosquito Inlet, Welcome, Duck Bay, West Inlet, East Inlet, Black / Dip, Detention, Inglis, Leven, Forth, Don, Mersey, Port Sorell, Tamar, Tomahawk, Boobyalla Inlet, Spring Bay, Derwent, North West Bay, Crooks, Port Cygnet, Esperance, D`Entrecasteaux, Catamaran, Lewis, Mainwaring, Montagu, Brid, Huon, and Payne Bay estuaries.
Poorly flushed	The Yarra, Cam, Emu, Blythe, Piper, Great Musselroe, Little Musselroe, Lee, Dover, Thirsty Lagoon, North East Inlet, Ansons Bay, Georges Bay, Moulting Lagoon, Buxton, Prosser, Blackman Bay, Carlton, Pittwater, Pipeclay Lagoon, Garden Island, Cloudy Bay, Cockle Creek, Southport, Southport Lagoon, New River lagoon, Lousia River, Louisa Creek, Bathurst Harbour, Mulcahy, Giblin, Macquarie Harbour, Pieman, Arthur, and Little Swanport estuaries.
Open / Closed	The Yellow Rock, Sea Elephant, Ettrick, Seal, Crayfish, Curries, Little Forester, , Rices, Rocky Head, Modder, Shack Rock, Pats, Foochow Inlet,_ Patriarch, Sellars Lagoon, Cameron Inlet, Logans Lagoon, Big Lagoon, Sloop Lagoon, Grants Lagoon, Scamander, Hendersons Lagoon, Templestowe, Denison, Saltwater Lagoon, Freshwater Lagoon, Bryans Lagoon, Meredith, Stoney, Lisdillon, Earlham Lagoon, Grindstone, Browns, South Cape Rivulet, Freney, Wanderer, Spero, Hibbs Lagoon, Henty, Little Henty, Lagoon, Pedder, Nelson Bay, Mines, Middle Inlet, Douglas, Dianas Basin, and Wrinklers Lagoon estuaries.

Sites in coastal and marine waters

Each site was assigned to an IMCRA 4.0 Mesoscale bioregion. The assignment to a mesoscale region was based on information from the Integrated Marine and Coastal Regionalisation of Australia (IMCRA 4.0). The linking of a site to a mesoscale region allowed for the site to be assigned to the appropriate provincial region (See Table 7). The majority of sites were found to be greater than 10 Km from the coast and subsequently were not able to be assigned to an OSRA segment.

Table 7. IMCRA4.0 Mesoscale bioregions by provincial Bioregion

Provincial Bioregion	Mesoscale Bioregion
Tasmanian Shelf Province	The Franklin, Davey, Bruny, and Freycinet mesoscale bioregions
Bass Strait Shelf Province	The Boags, and Central Bass Strait mesoscale bioregions
South East Shelf Transition	The Flinders, and Twofold Shelf mesoscale bioregions
Western Bass Strait Shelf Transition	The Otway mesoscale bioregion

Sites in Groundwater

In some instances, the same location was monitored by multiple organisations or under many projects by a single organisation. Under such instances the location became a single site with monitoring data differentiated on the basis of project. Each site can be assigned to one of thirteen broad scale connected water regions (Table 8). This assignment to a connected water region is based on information from the Groundwater and Surface water Connectivity in Tasmania report (Sheldon, 2011).

Table 8. Connected water regions and associated bores

Final Connected Water Region	Bores
Basins	Hagley, Cressy, Ross, Pawleena, Pipers and Jetsonville
Central Plateaus	Osmaston
Coastal Sands	Waterhouse and Bicheno
East Coast Rolling Hills	Port Arthur, Buckland, and Little Swanport
Karst	Chudleigh and Togari
Mid North Rolling Hills	Nil
North East Highlands	St Marys, Lilydale, Branxholm and Winnaleah
North West Basalt Plateaus and Valleys	Montagu, Trowutta, South Forest, Calder, Hampshire, Mooreville, Barrington, Spreyton, and Beulah
South East Plateaus and Escarpments	Lower Snug
Southern Midland Rolling Hills	Melton Mowbray, Tunnack, and Bothwell
West Coast Plateaus	Nil
Western Ridges and Valleys	Nil
Huon and Bruny Rolling Hills	Huonville

5.2 Ecosystem Condition

In order to assign an ecosystem condition to a site appropriate resources were used for the particular water type (Table 9.).

Table 9. Water Types and associated condition resources

Water Type	Condition resources
Inland	Tasmanian Vegetation Project (by DPIPWE). Conservation of Freshwater Ecosystems Values (CFEV) Project (by DPIPWE) Water Information Management System (WIMS) database National Pollution Inventory NPI database Mine site database held by Mineral Resources of Tasmania Aerial images – e.g. Google Earth Expert opinion from within the public and private sector
Estuarine	Conservation of Freshwater Ecosystems Values (CFEV) Project (by DPIPWE) Coastal and Estuarine Resource Condition Assessment Project Oils Spill Response Atlas (OSRA) database Landscape Logic program by University of Tasmania (UTAS) National Pollution Inventory NPI database Aerial images – e.g. Google Earth Expert opinion from within the public and private sector
Coastal and Marine	Coastal and Estuarine Resource Condition Assessment Project Oils Spill Response Atlas (OSRA) database National Pollution Inventory NPI database Expert opinion from within the public and private sector
Ground Water	Conservation of Freshwater Ecosystems Values (CFEV) Project (by DPIPWE) Ground Water Information Management System (GWIMS) database Expert opinion from within the public and private sector Guidelines for groundwater quality protection in Australia

These resources provide information on the following:

- The degree of catchment disturbance (through such activities as agriculture, forestry, mining and aquaculture).
- Riparian vegetation condition.
- Degree of urban development within the catchment.
- Location of point source discharges (such as sewage treatment plant and industrial discharges) and diffuse sources of emissions (such as urban, forestry and agricultural runoff).
- Disturbance to hydrological connectivity within the catchment from in-stream weirs or dams for irrigation and/or power generation.
- Perturbations to flow regime by abstraction or regulation.
- Naturalness of individual estuaries.
- Naturalness values, and sensitivity to change of freshwater and marine environments.
- Condition of Groundwater Dependent Ecosystems (GDEs)

5.3 Key Indicators for Water Types

The parameters or indicators measured at a site are dependent on the water type and the question being asked by the monitoring program. For each water type the indicators that were widely monitored (spatially and temporally) were selected for the derivation of DGVs for aquatic ecosystems. These are outlined in Table 10.

Table 10. Indicators for which DGVs were derived for each water type

Water Type	Indicator
Inland	Physico-chemical: Dissolved Oxygen, Conductivity pH, Turbidity and, Water Temperature. Nutrients: TAN (NH3 and NH4+), Nitrate, Nitrite, Total Nitrogen, Dissolved Reactive Phosphorus, Total Phosphorus and, Total Suspended Solids (TSS). Biological: AUSRIVSA Band, OE50, OE50Signal, Signal Index, Taxon Diversity, EPT Diversity, and Macroinvertebrate Composition, Fish O/E, Fish O/P, Proportion native fish abundance, proportion native fish species, proportion native biomass, Chlorophyll a, algal cover and riparian shading*
Estuarine	Physico-chemical: Dissolved Oxygen, Salinity, pH, Turbidity and, Water Temperature. Nutrients: Ammonia/TAN (NH3 and NH4+), Nitrate, Nitrate, Nitrate and Nitrite, Total Nitrogen, Dissolved Reactive Phosphorus, Total Phosphorus, Silicate, and Dissolved Organic Carbon. Biological: Chlorophyll a.
Coastal and Marine	Physico-chemical: Dissolved Oxygen, Salinity, pH, Turbidity, and Water Temperature. Nutrients: Nitrate, Orthophosphate, and Silicate. Other: Fluorescence and PAR (Photosynthetically Active Radiation).
Groundwater	Physico-chemical: Conductivity, pH, and TDS. Metals: Iron, Calcium, Magnesium, Aluminium, Sodium, and Potassium. Other: Nitrate, and Sulphate, Chloride, Fluoride, Bicarbonates, Carbonates., Temporary Hardness, Permanent hardness, and Alkalinity.

*For details of the biological indicators for inland waters refer to Appendix A.

5.4 Data requirements

In order for data from a site to be considered for the derivation of Guideline Values (GVs) or DGVs, the period over which the data was collected, frequency of collection and quality of the data were considered. For Inland and estuarine data flow conditions at the time of sampling was also a consideration for data suitability.

5.4.1 Period of Record

Data collected post 1990 was considered to be appropriate for determining site-specific GVs and for DGVs for all water types. For coastal and marine waters data from 1980 onward was deemed appropriate for deriving DGVs. Groundwater information from 1980 onward is appropriate for deriving regional DGVs.

5.4.2 Frequency of sampling

Water quality measurements represent a random sample from a statistical population (the water body). In order to have a degree of confidence that the water quality measurements provide a true reflection of a water body an acceptable level of sampling frequency is required. A confidence interval of 95% was deemed appropriate as this this provides 95% certainty that the GVs and DGVs which are based on the 80th%ile or 20th and 80th%ile values provide a true percentile value. In order for this a minimum sample number is required for each percentile being estimated (Table 11).

Table 11. Minimum sample number required for 95% confidence for percentiles (Goudey, 1999)

Sample Number required for 95% confidence Interval	Description
0	No Data (ND)
1-5	Insufficient Data (ID)
≥ 6	Median/50th%ile
≥ 14	20th, 50th, 80th%ile
≥ 29	10th, 20th, 50th, 80th,90th%ile
≥ 35	5th,10th, 20th, 50th, 80th, 90th,95th%ile

On this basis, sites monitored at monthly intervals for a minimum of two years were deemed appropriate. It should be noted that coastal and marine data was not collected from the same site over a period of visits but rather multiple sites within the same region over time and thus the data was deemed suitable for the derivation of interim DGVs only. In addition, only measurements taken within 200 metres of the surface were deemed suitable as they correspond to the photic zone. For inland waters biological information is collected twice annually (spring and autumn) on this basis it was deemed that a minimum of 6 combined season outputs are required to provide an acceptable level of statistical robustness and certainty. Due to the frequency of sampling of bores the groundwater data available is deemed suitable for the derivation of interim DGVs only.

5.4.3 Data quality and parameter standardisation

The ability of the data provided to be used for its intended purpose relies on the quality of the data. Data quality was categorised as either good, average, poor or unknown. In-situ measurements made in accordance with the manufacturers specifications for the field instrument were deemed to be of good quality. Laboratory samples taken, stored, transported and analysed at an accredited laboratory in accordance with the sampling guidelines for the particular parameter were deemed to be of good quality. Where a result was reported as below the Limit of Reporting (LoR) by a laboratory the value was halved. Data that was unable to have the quality ascertained was deemed of unknown quality. Obvious errors and duplicates were removed from each dataset prior to incorporation in the database. A key component in collating data from multiple sources is the standardisation of parameter names and units. All parameters were matched to an existing parameter on the EPA Water Database where possible. Where a parameter could not be matched due to being either a new parameter or having a different measurement unit an additional parameter was created. All parameters on the Water Database were assigned globally accepted identifiers depending on the indicator type. (eg: Aphia_Id for algae, CAS Registry Number for chemicals)

5.4.4 Base flow and non-base flow conditions

Water quality for freshwater and estuaries can have a strong dependence on the local hydrology. Water quality under high flow and no flow conditions is typically markedly different from that which occurs under base flow conditions. Under high flow conditions, much of the water is derived from surface overflow and may contain high levels of suspended solids and pollutants. During periods of no flow water quality becomes poorer with increasing stagnation. Under base flow conditions, when most of the flow is derived from sub surface and or groundwater inflows, quality is generally stable. Refer to Figure 11 for a generic flow duration curve illustrating high flow event, base flow conditions and no flow event.

Base flow is defined here as being below the 98th percentile of flow for the monitoring period and greater than zero flow. Where a sampling event occurs within 30 days of the 98th percentile being exceeded or in the absence of flow then the data has been excluded from the dataset.

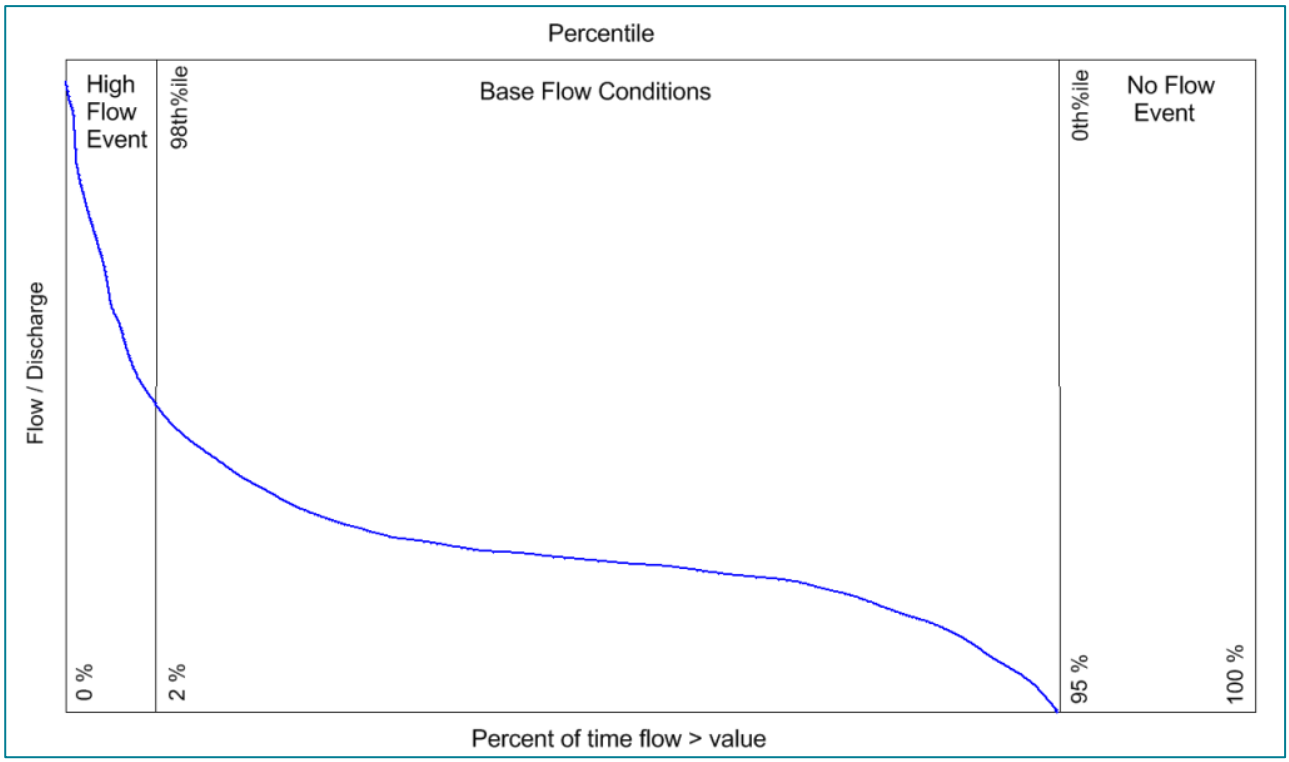


Figure 11. Generic flow duration curve

Where possible the guideline values have been derived from data collected under base flow conditions**,** i.e. flow conditions that occur 98 percent of the time within the catchment. Flow information was derived from gauging stations for the period of record from the Water Information System of Tasmania (WIST). This data is now available through the Water Information Tasmania Web Portal. For inland sites where no gauging information was available the sampling event was assumed to occur during baseflow conditions unless field notes indicated to the contrary. The Estuarine data provided by IMAS included information on rainfall as a surrogate for flood condition. GVs for high flow or 'flood events' and for no flow events have also be derived at a site-specific level for inland sites. Event based GVs are site-specific and are not applicable at the catchment or hydrological region scale as they are highly dependent on local conditions.

6. Glossary

Abbreviation	Description
Acidity	having a high hydrogen ion concentration (low pH).
Algae	Comparatively simple chlorophyll-bearing plants, most of which are aquatic and microscopic in size.
Alkalinity	The quantitative capacity of aqueous media to react with hydroxyl ions. The equivalent sum of the bases that are titratable with strong acid. Alkalinity is a capacity factor that represents the acid-neutralising capacity of an aqueous system.
Anion	negatively charged ion.
Anthropogenic	Produced or caused by humans.
Aquatic ecosystem	Any watery environment from small to large, from pond to ocean, in which plants and animals interact with the chemical and physical features of the environment.
Biochemical oxygen demand (BOD)	The decrease in oxygen content in mg/L of a sample of water in the dark at a certain temperature over a certain of period of time which is brought about by the bacterial breakdown of organic matter. Usually the decomposition has proceeded so far after 20 days that no further change occurs. The oxygen demand is measured after 5 days (BOD_5), at which time 70% of the final value has usually been reached.
Biodiversity (biological diversity)	Biological diversity is defined as the variety of life forms, including the different plants, animals and micro-organisms, the genes they contain and the ecosystems of which they are a part, including ecological processes.
Biological community	An assemblage of organisms characterised by a distinctive combination of species occupying a common environment and interacting with one another.
Catchment	The total area draining into a river, reservoir, or other body of water.
Cation	positively charged element.
Chemical oxygen demand	The amount of oxygen required to oxidise all organic matter that is susceptible to oxidation by a strong chemical oxidant.
Coastal Waters	The part of the sea that is, from time to time included in the coastal waters of the State by virtue of the Coastal Water (State Powers) Act 1980 of the Commonwealth (Environment Protection (Sea Dumping) Act 1987 or subsequent replacement legislation.
Concentration	The quantifiable amount of chemical in the surrounding water, food or sediment.
Contaminant	Biological (e.g. bacterial and viral pathogens) and chemical (see Toxicants) introductions capable of producing an adverse response (effect) in a biological system, seriously injuring structure or function or producing death.
Cyanobacteria	A photosynthetic bacteria that can produce strong toxins.
Ecologically sustainable development	Development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.
Enterococci	Any streptococcal bacteria normally found in the human intestinal tract; usually non-pathogenic.
EPA Board	The Board of the Environmental Protection Authority.
Ecotoxicity	the levels and types of contaminants that cause harm to animals and plants
Groundwater	Any water occurring in a geological formation.
Abbreviation	Description
Guideline Values (Default)	These are the concentrations (or loads) of the key indicators measured for the ecosystem, below which there exists a low risk that adverse biological (ecological) effects will occur.

Abbreviation	Description
Hardness	The concentration of all metallic cations, except those of the alkali metals, present in water. In general, hardness is a measure of the concentration of calcium and magnesium ions in water and is frequently expressed as mg/L calcium carbonate equivalent.
Homestead supply	The taking of water from a water course or lake as a right under Section 48(2) of the Water Management Act 1999, or groundwater, for domestic purpose, i.e, personal use for drinking, cooking, and washing. (Subsequent replacement legislation will apply).
Key Indicator	A parameter that can be used to provide a measure of the quality of water.
Organism	Any living animal or plant; anything capable of carrying on life processes.
Parameter	A measurable or quantifiable characteristic or feature, i.e., an element, compound or characteristic of water, or biological organism or community living in water.
pH	Value taken to represent the acidity or alkalinity of an aqueous solution. It is defined as the negative logarithm of the hydrogen ion acidity of the solution.
Phytoplankton	The plant portion of the plankton.
Plankton	Plants (phytoplankton) and animals (zooplankton), usually microscopic, floating in water.
Primary Contact	Bodily immersion or submersion where there is direct contact with the water and includes such as swimming, diving water skiing and surfing.
Pristine	Predominantly unchanged by human activity or influence.
Protected Environmental Values	Values or uses -The particular values or uses of the environment, e.g., ecosystem health, public benefit, welfare and health, for which it has been determined should be protected. Several environmental values may be designated for a specific waterbody.
Reference condition	An environmental quality or condition that is defined from as many similar systems as possible and used as a benchmark for determining the environmental quality or condition to be achieved and/or maintained in a particular system of equivalent type.
Salinity	The presence of soluble salts in or on soils or in water.
Secondary contact	Activities in which there is likely to be some direct contact with water but where it is unlikely the water will be swallowed. Activities include paddling, washing, boating and fishing.
Sediment	Unconsolidated mineral and organic particulate material that has settled to the bottom of aquatic environments.
Stressors	The physical, chemical or biological factors that can cause an adverse effect on an aquatic ecosystem as measured by the condition indicators.
Surface waters	All waters on the land surface, i.e. freshwater, and estuarine and marine waters.
Thermotolerant coliform	Also known as faecal coliforms. However, in sub-tropical areas, thermotolerant coliforms may on some occasions include microorganisms of environmental rather than feacal origin.
Toxicant	A chemical capable of producing an adverse response (effect) in a biological system at environmental concentrations that might be encountered in the environment, seriously injuring structure or function or producing death. Examples include pesticides, metals and biotoxins.
Trigger values	These are the concentrations (or loads) of the key indicators measured for the ecosystem, below which there exists a low risk that adverse biological (ecological) effects will occur. For indicators that have a range such as DO and pH the measured test site value should be between the range for the risk to be low. If a risk of impact is determined then some action is 'trigger', either further ecosystem specific investigations or management actions.

Abbreviation	Description
Water quality guideline	A numerical concentration limit or narrative statement that has been established to support and protect the designated use of water. It is the level of key indicators which should be met in order to protect an environmental value.
Water quality objective	It is the most stringent set of water quality guidelines which should be met to achieve all the protected environmental values.
Water quality target	A numerical concentration limit or narrative statement that has been established to support and protect the designated use of water. It is the level of key indicators which should be met in order to protect an environmental value. Water quality targets (i.e., intermediate water quality objectives) can be set for progressively improving water quality.
Zooplankton	The animal portion of the plankton.

7. Resources

Tasmanian Resources

The *State Policy on Water Quality Management 1997 (*SPWQM*)*

PEVs for Tasmanian Surface waters.

Conservation of Freshwater Ecosystems Values (CFEV)

Water Information System of Tasmania (WIST).

Water Information Tasmania Web Portal.

A decision tree for monitoring and management of Tasmanian estuaries. Fact sheet for managers and policy-makers #16. March 2011. landscape Logic program.

Hughes, J. M. R, (1987). Hydrological Characteristics and Classification of Tasmanian Rivers. *Australian Geographical Studies* **25**, 61-82.

Sheldon, R. (2011). Groundwater and Surface Water Connectivity in Tasmania: Preliminary Assessment and Risk Analysis. Water and Marine Resources Division, Department of Primary Industries, Parks, Water and Environment, Hobart.

Ezzy, A. (2004). An overview of the Mineral Resources Tasmania statewide groundwater monitoring network. Mineral Resources Tasmania, Hobart.

National Resources

Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018 (ANZG 2018)

National Water Quality Management Strategy1994 (NWQMS).

Council of Australian Government's (COAG) Water Reform Agenda

Environmental Management and Pollution Control Act 1994 (EMPCA)

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

Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ, 2000).

Water Quality management Framework

Toxicant DGVs in freshwater and marine water

Water quality for primary industries

Australian guidelines for water recycling

Australian Drinking Water guidelines

Guidelines for Managing Risks in Recreational water

Cultural and spiritual values of waterways

Food Standards

National Sediment Quality Guidelines

Integrated Marine and Coastal Regionalisation of Australia IMCRA 4.0

Goudey, R., (1999). Assessing water Quality Objectives: Discussion Paper. EPA, Southbank, Vic.

Users' Guide for Estuarine, Coastal and Marine Indicators for Regional NRM Monitoring

8. Appendices

Appendix A: Biological Indicators for Inland waters

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

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

SIGNAL Index

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

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

Derived guidelines for Biological Indicators

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

Macroinvertebrate abundance

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

Native fish indicators

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

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

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

Algal indicators

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

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

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

Appendix B: Data Providers and Datasets

Data Provider	Database	DataSets Description	Database Manager
Hydro Tasmania	TimeStudio proprietary software	Water Quality Data for Operation purposes	Hydro Tasmania
Hydro Tasmania	River Health & Fish Access database	AUSRIVAS survey for Operational purposes	Water Assessment - DPIWE
Water Assessment - DPIWE	Aquarius proprietary software	General Water Quality Monitoring for catchment assessments	Water Assessment - DPIWE
Water Assessment - DPIWE	River Health & Fish Access database	AUSRIVAS and Fish surveys for catchment assessments	Water Assessment - DPIWE
NRM North	River Health & Fish Access database	AUSRIVAS surveys for catchment assessments	Water Assessment - DPIWE
NRM North	Spigot proprietary software	General Fresh Water and Estuary Water Quality Monitoring	NRM North
Cradle Coast NRM	Aquarius proprietary software	General Water Quality Monitoring	Water Assessment - DPIWE
Cradle Coast NRM	River Health & Fish Access database	AUSRIVAS surveys for catchment assessments	Water Assessment - DPIWE
Forestry Tasmania	Forestry Tasmania Access database	Water Quality Data for Operation purposes	Forestry Tasmania
EPA Water Section	EPA Water Database (DRAIN) in-house software	Ongoing investigations into specific environmental impacts	EPA Water Section
Derwent Estuary Program	EPA Water Database (DRAIN) in-house software	Estuary Monitoring Program	EPA Water Section
Department of Health and Human Services	excel spread sheets	Food security	Department of Health and Human Services
Marine Resources - DPIWE	excel spread sheets	Huon Estuary Water Quality Monitoring	Marine Resources - DPIWE
CSIRO	Data Warehouse	Various Research Projects in Marine water	CSIRO
IMAS	excel spread sheets	Various Research Projects in Estuarine water	IMAS

Appendix C: HEV and SMEV reference sites for Inland waters

The sites in the following lists were those used in the derivation of the DGVs for inland aquatic ecosystems.

HEV WATER QUALITY REFERENCE SITES	Hydrological Region	Catchment	Easting	Northing	Data Provider
ALLANS RIVULET UPSTREAM TARANNA	H1	Tasman	572595	5230720	DPIPWE
ANSONS RIVER DOWNSTREAM BIG BOGGY CREEK	H1	Musselroe - Ansons	602315	5455303	DPIPWE
ARM RIVER AT ROAD BRIDGE	H1	Mersey	434752	5384433	Hydro Tasmania
BRUSHY RIVULET AT BIRRALEE ROAD	H1	Meander	486314	5408199	NRM North
COQUET CREEK AT TASMAN HIGHWAY	H1	North Esk	528312	5421483	DPIPWE
DOUGLAS RIVER UPSTREAM TASMAN HIGHWAY	H1	Douglas - Scamander	604115	5373703	DPIPWE
GREAT FORESTER RIVER AT SCOTTSDALE WS INTAKE	H1	Great Forester - Brid	542200	5431600	NRM North
GREAT FORESTER RIVER UPSTREAM TROUT FARM	H1	Great Forester - Brid	542462	5431483	DPIPWE
GROOM RIVER AT ANCHOR ROAD, PYENGANA	H1	George	584875	5434772	NRM North
HARDY CREEK AT KARST SINK HOLE	H1	Leven	414206	5414793	Cradle Coast NRM
JACKEYS CREEK DOWNSTREAM JACKEYS MARSH	H1	Meander	471347	5386301	DPIPWE
LEVEN RIVER AT TAYLORS BRIDGE	H1	Leven	414334	5414662	Cradle Coast NRM
MOSTYN HARDY CREEK ABOVE KARST SYSTEM	H1	Leven	414168	5414892	Cradle Coast NRM
NILE RIVER AT FISHERS TIER	H1	South Esk	545952	5394975	NRM North
NORTH ESK RIVER AT PHILLPS ROAD	H1	North Esk	544320	5415758	DPIPWE
PIPERS RIVER AT UNDERWOOD	H1	Pipers	517153	5428813	NRM North, DPIPWE
POWERS RIVULET AT TERRYVALE ROAD BRIDGE	H1	George	593761	5427259	NRM North
RANSOM RIVER AT MURDOCHS ROAD	H1	George	588272	5434770	NRM North
ROCKY CREEK AT LILYDALE ROAD	H1	Pipers	517895	5431500	NRM North
SECOND RIVER AT DOAKS ROAD	H1	Pipers	523831	5432006	NRM North
SNUG RIVULET UPSTREAM SNUG TIERS ROAD BRIDGE	H1	Derwent Estuary - Bruny	519323	5231230	DPIPWE
WINTER BROOK AT LOONGANA ROAD BRIDGE	H1	Leven	417926	5415178	Cradle Coast NRM
COAL RIVER AT NEW COUNTRY MARSH ROAD	H2	Pittwater - Coal	542912	5295582	DPIPWE
LITTLE DEN CREEK AT LAKE HIGHWAY	H2	Jordan	511362	5303032	DPIPWE
MEREDITH RIVER AT SWANSEA	H2	Swan - Apsley	585926	5336159	DPIPWE

HEV WATER QUALITY REFERENCE SITES	Hydrological Region	Catchment	Easting	Northing	Data Provider
SWAN RIVER UPSTREAM HARDINGS FALLS	H2	Swan - Apsley	591377	5366584	DPIPWE
ANDREW RIVER AT KELLY BASIN ROAD	H3	Gordon - Franklin	385811	5324983	Cradle Coast NRM
ARVE RIVER (HAYMONS)	H3	Huon	484277	5221898	Forestry Tasmania
ARVE RIVER MIDDLE	H3	Huon	484270	5221547	Forestry Tasmania
ARVE RIVER UPPER	H3	Huon	481527	5215782	Forestry Tasmania
BIG ROCKY CREEK AT HEEMSKIRK ROAD	H3	Pieman	341552	5371582	Cradle Coast NRM
BREN	H3	Huon	476559	5231335	Forestry Tasmania
CRYSTAL CREEK	H3	Huon	472765	5236084	Forestry Tasmania
ESPERANCE RIVER UPPER	H3	Huon	484263	5213346	Forestry Tasmania
FRANKLAND RIVER AT BLACKWATER ROAD	H3	Arthur	321907	5438450	Cradle Coast NRM
GLOVERS CREEK 1	H3	Huon	475602	5233253	Forestry Tasmania
GLOVERS CREEK 2	H3	Huon	476459	5233855	Forestry Tasmania
HAWKERS CREEK LOWER	H3	Huon	500923	5201055	Forestry Tasmania
HAWKERS CREEK UPPER	H3	Huon	500151	5198762	Forestry Tasmania
HUON RIVER ABOVE FRYING PAN CREEK	H3	Huon	487116	5235309	DPIPWE
HUON RIVER 800 METRES DS SOUTHWOOD ROAD	H3	Huon	485414	5233741	Forestry Tasmania
HUON RIVER AT TAHUNE BRIDGE	H3	Huon	477893	5228576	Forestry Tasmania
HUON RIVER UPSTREAM OF ARVE RIVER	H3	Huon	485189	5232766	Forestry Tasmania
ISABELLA CREEK	H3	Huon	471999	5236656	Forestry Tasmania
JOHNS CREEK	H3	Huon	473752	5228562	Forestry Tasmania
KERMANDIE RIVER LOWER	H3	Huon	487508	5214832	Forestry Tasmania
KERMANDIE RIVER UPPER	H3	Huon	490127	5218630	Forestry Tasmania
KING CREEK	H3	Huon	476085	5231181	Forestry Tasmania
KROANNA CREEK	H3	Huon	473495	5228762	Forestry Tasmania
LAUREL CREEK	H3	Huon	475715	5228568	Forestry Tasmania
LEIGHS CREEK	H3	Huon	476822	5228756	Forestry Tasmania
LINDSAY RIVER AT HEEMSKIRK ROAD	H3	Arthur	331007	5422947	Cradle Coast NRM
LITTLE DENISON RIVER AT LINK ROAD	H3	Huon	482146	5242818	Forestry Tasmania

HEV WATER QUALITY REFERENCE SITES	Hydrological Region	Catchment	Easting	Northing	Data Provider
LITTLE DENISON RIVER OFF TOP OF DENISON ROAD	H3	Huon	476873	5241827	Forestry Tasmania
LUNE RIVER LOWER	H3	Huon	492300	5193114	Forestry Tasmania
LUNE RIVER UPPER	H3	Huon	485769	5193052	Forestry Tasmania
NELSON BAY RIVER AT TEMMA ROAD BRIDGE	H3	Nelson Bay	305941	5444263	DPIPWE
NELSON BAY RIVER AT REBECCA ROAD	H3	Nelson Bay	317627	5437604	Cradle Coast NRM
NEWELL CREEK AT MT JUKES ROAD	H3	King - Henty	379373	5331210	Cradle Coast NRM
PICTON RIVER LOWER	H3	Huon	477031	5227188	Forestry Tasmania
PICTON RIVER UPPER	H3	Huon	474315	5213580	Forestry Tasmania
RUSSELL RIVER LOWER	H3	Huon	482689	5245700	Forestry Tasmania
RUSSELL RIVER UPPER	H3	Huon	476453	5252593	Forestry Tasmania
STANLEY RIVER AT PIEMAN ROAD BRIDGE	H3	Pieman	357686	5381608	Cradle Coast NRM
SWANSON CREEK	H3	Huon	476003	5231254	Forestry Tasmania
TAHUNE	H3	Huon	477884	5228671	Forestry Tasmania
TOMALAH CREEK UPPER	H3	Huon	473084	5229178	Forestry Tasmania
UPPER KING	H3	Huon	484326	5233110	Forestry Tasmania
WARRA CREEK 1	H3	Huon	476034	5231142	Forestry Tasmania
WARRA CREEK 2	H3	Huon	478037	5230728	Forestry Tasmania
BLACK RIVER AT NEWHAVEN ROAD	H4	Black – Detention	363562	5460835	Cradle Coast NRM
DETENTION RIVER AT NEWHAVEN ROAD	H4	Black - Detention	372942	5464660	Cradle Coast NRM
DIP RIVER AT RABALGA TRACK	H4	Black - Detention	368811	5449615	Cradle Coast NRM
DUCK RIVER AT WEDGE PLAINS ROAD	H4	Duck	347156	5458241	Cradle Coast NRM
HEBE RIVER AT MYALLA ROAD	H4	Inglis - Flowerdale	372711	5454083	Cradle Coast NRM, DPIPWE
FLOWERDALE RIVER AT MEUNNA ROAD	H4	Inglis - Flowerdale	376011	5446883	Cradle Coast NRM, DPIPWE
MONTAGU RIVER UPSTREAM ROGER RV ROAD	H4	Montagu	332212	5451484	Cradle Coast NRM
UN-NAMED TRIBUTARY AT BARCOO ROAD	H4	Montagu	327111	5477458	Cradle Coast NRM, DPIPWE

SMEV WATER QUALITY REFERENCE SITES	Hydrological Region	Catchment	Easting	Northing	Data Provider
BARROW CREEK AT TASMAN HWY	H1	North Esk	529312	5424483	DPIPWE
BEN LOMOND RIVULET AT NILE ROAD	H1	South Esk	540189	5377852	NRM North
BENNIES CREEK AT TASMAN HWY	H1	North Esk	530112	5425184	DPIPWE
BUFFALO BROOK AT BONNEYS PLAINS ROAD	H1	South Esk	551384	5372774	NRM North
CAMDEN RIVULET AT DIDDLEUM ROAD	H1	North Esk	538812	5425384	DPIPWE
ELIZABETH DOWNSTREAM OF LAKE LEAKE	H1	Macquarie	565768	5349580	NRM North
FORD RIVER AT UPPER BLESSINGTON	H1	North Esk	547913	5409033	NRM North, DPIPWE
FRANKLIN RIVULET AT DOLERITE ROAD	H1	Rubicon	476060	5425870	Cradle Coast NRM
GREAT MUSSLEROE RIVER AT BROWNS BRIDGE ROAD	H1	Musselroe - Ansons	591400	5467600	NRM North
JEAN BROOK AT BRIDGE TO LEVEN CANYON LOOKOUT	H1	Leven	418785	5415761	Cradle Coast NRM
LIFFEY RIVER AT BRACKNELL PICNIC AREA	H1	Meander	495862	5389058	NRM North
MACQUARIE RIVER AT TREFUSIS	H1	Macquarie	549805	5330010	DPIPWE
MEANDER RIVER AT MEANDER	H1	Meander	468012	5389082	Hydro Tasmania
MERSEY RIVER AT UNION BRIDGE	H1	Mersey	444500	5403700	NRM North
MUSSELBORO CREEK AT BURNS CREEK ROAD	H1	North Esk	537600	5409600	NRM North
NILE RIVER AT DEDDINGTON	H1	South Esk	534200	5394261	DPIPWE
NORTH ESK RIVER AT CAMDEN ROAD	H1	North Esk	544613	5408233	DPIPWE
NORTH ESK RIVER OFF CAMDEN ROAD	H1	North Esk	544013	5411133	DPIPWE
NORTH GEORGE RIVER AT BINNS ROAD BRIDGE	H1	George	579408	5431350	NRM North
PATERSONIA RIVULET AT TARGA HILL	H1	North Esk	527812	5426683	DPIPWE
QUAMBY BROOK DOWNSTREAM OF EDEN RIVULET	H1	Meander	476612	5397783	DPIPWE
RANSOM RIVER AT SWEETS HILL	H1	George	590017	5433128	DPIPWE
RIVER O PLAIN CREEK AT BLESSINGTON ROAD	H1	North Esk	541913	5406783	DPIPWE
SCAMANDER RIVER UPSTREAM SCAMANDER WS	H1	Scamander - Douglas	598535	5411073	DPIPWE
SEVEN TIME CREEK AT TASMAN HIGHWAY	H1	North Esk	531512	5426883	DPIPWE
SOUTH GEORGE RIVER AT DOBSONS ROAD BRIDGE	H1	George	575430	5426671	NRM North
ST PATRICKS RIVER AT CORKERYS ROAD	H1	North Esk	534112	5428584	NRM North, DPIPWE

SMEV WATER QUALITY REFERENCE SITES	Hydrological Region	Catchment	Easting	Northing	Data Provider
ST PATRICKS RIVER AT EAST DIDDLEUM ROAD	H1	North Esk	539012	5425983	DPIPWE
TOMAHAWK RIVER AT WATERHOUSE ROAD	H1	Boobyalla - Tomahawk	562717	5470612	NRM North
TOOMS RIVER DOWNSTREAM TOOMS LAKE	H1	Macquarie	564597	5326436	DPIPWE
WILMOT RIVER AT SPELLMANS BRIDGE	H1	Forth	430048	5422011	Cradle Coast NRM
APSLEY RIVER UPSTREAM COLES BAY ROAD BRIDGE	H2	Swan - Apsley	602542	5356258	DPIPWE
COAL RIVER AT RIVER ROAD	H2	Pittwater - Coal	539512	5299482	DPIPWE
CRAIGBOURNE CREEK AT LINK ROAD	H2	Pittwater - Coal	535812	5291282	DPIPWE
EXE RIVULET AT EXE SUGARLOAF	H2	Jordan	518412	5314882	DPIPWE
GRAHAMS CREEK AT ELDERSLIE ROAD	H2	Jordan	509512	5279582	DPIPWE
JORDAN RIVER AT MUD WALLS ROAD	H2	Jordan	525562	5305582	DPIPWE
WHITE KANGAROO RIVULET	H2	Pittwater - Coal	538210	5278141	DPIPWE
ARVE RIVER LOWER	H3	Huon	485583	5231680	Forestry Tasmania
BLACKBURN CREEK AT LAKE HWY	H3	Ouse	492112	5331173	Hydro Tasmania
BOGGY MARSH RIVULET AT BASHAN Road	H3	Ouse	478193	5323763	Hydro Tasmania
ESPERANCE RIVER AT DOVER WATER SUPPLY INTAKE	H3	Huon	497287	5202087	Forestry Tasmania, DPIPWE
HUON RIVER AT JUDBURY	H3	Huon	494152	5239202	DPIPWE
KINGS CREEK UPSTREAM OF HUON RIVER (SOUTHWOOD)	H3	Huon	484278	5233143	Forestry Tasmania
LITTLE HENTY RIVER STRAHAN HIGHWAY BRIDGE	H3	King - Henty	364612	5354883	Cradle Coast NRM
OUSE RIVER AT MARLBOROUGH HWY	H3	Ouse	470612	5351433	Hydro Tasmania
STRINGERS CREEK LOWER	H3	Huon	502619	5199869	Forestry Tasmania
KINGS CREEK UPPER	H3	Huon	484132	5234852	Forestry Tasmania
TYENNA RIVER AT NEWBURY	H3	Lower Derwent	474681	5269961	DPIPWE
BLACK RIVER AT SOUTH FOREST	H4	Black - Detention	356558	5474019	DPIPWE
BLACK RIVER AT SPION KOP ROAD FORD	H4	Black - Detention	356427	5470900	Cradle Coast NRM
BLYTHE RIVER DOWNSTREAM OF CAMENA ROAD BRIDGE	H4	Blythe	412300	5441460	Cradle Coast NRM
CAM RIVER AT OONAH	H4	Cam	384086	5435232	Cradle Coast NRM

SMEV WATER QUALITY REFERENCE SITES	Hydrological Region	Catchment	Easting	Northing	Data Provider
COOPERS CREEK AT 10 FOOT TRACK	H4	Inglis - Flowerdale	381211	5454484	DPIPWE
DUCK RIVER AT MAGUIRES ROAD	H4	Duck	342111	5458083	DPIPWE
EMU RIVER NEAR HAMPSHIRE	H4	Emu	398956	5430557	Cradle Coast NRM
FLOWERDALE RIVER OFF TEN FOOT TRACK	H4	Inglis - Flowerdale	380711	5455584	DPIPWE
GALEFORD CREEK 700 M DOWNSTREAM OF DAM	H4	Montagu	318911	5468483	DPIPWE
HARCUS RIVER AT HARCUS RIVER ROAD	H4	Welcome	315000	5478000	DPIPWE
HARDMANS CREEK AT PREOLENNA ROAD	H4	Inglis - Flowerdale	377061	5448033	DPIPWE
HELLYER RIVER SOUTH OF HAMPSHIRE	H4	Arthur	389361	5418384	Cradle Coast NRM
INGLIS RIVER 2KM SOUTH OF TAKONE	H4	Inglis - Flowerdale	385711	5440283	DPIPWE
MONTAGU RIVER AT DONALDS ROAD	H4	Montagu	331111	5453483	DPIPWE
MONTAGU RIVER DOWNSTREAM OF CHRISTMAS HILLS ROAD	H4	Montagu	327700	5455300	DPIPWE
ROGER RIVER AT CROLES ROAD	H4	Duck	336011	5451783	DPIPWE
ROGER RIVER AT ROGER RIVER ROAD	H4	Duck	333161	5455333	DPIPWE

HEV BIOLOGICAL CONDITION REFERENCE SITES	Hydrological region	Catchment	Easting	Northing	Data Provider
Ansons River at Clifford Road	H1	Musselroe - Ansons	595047	5439943	DPIPWE
Ansons River at Gauging Station	H1	Musselroe - Ansons	602364	5455308	DPIPWE
Arm River at Arm River Weir	H1	Mersey	434761	5384446	Hydro Tasmania, DPIPWE
Beckett Creek at Camden Road	H1	North Esk	544233	5415631	DPIPWE
Catos Creek at Catos Creek Road	H1	Scamander - Douglas	595972	5409166	DPIPWE
Cattley Creek at Black Marsh Road	H1	Leven	404630	5410390	DPIPWE
Crabtree Rivulet at Mitchells Road	H1	Huon	503860	5247259	DPIPWE
Dempster Creek at Loongana Road	H1	Leven	409901	5416550	DPIPWE
Douglas River at Tasman Highway	H1	Scamander - Douglas	604415	5373731	DPIPWE
Dukes River at Dukes Marshes	H1	South Esk	593884	5380505	DPIPWE
Dunns Creek off Maurice Road	H1	Ringarooma	556736	5427791	DPIPWE

HEV BIOLOGICAL CONDITION REFERENCE SITES	Hydrological region	Catchment	Easting	Northing	Data Provider
Eden Rivulet at Eden Road	H1	Meander	479314	5393453	DPIPWE
Elizabeth River at Tea Tree Hill	H1	Macquarie	561294	5356163	DPIPWE
Fish River at Mersey Forest Road	H1	Mersey	435595	5375326	Hydro Tasmania, DPIPWE
Forth River at Pallawah Road	H1	Forth-Wilmot	427627	5393033	Hydro Tasmania, DPIPWE
Forth River downstream of Wolfram Mine	H1	Forth-Wilmot	425761	5385964	DPIPWE
Garden Island Creek off Garden Island Creek Road	H1	Huon	514567	5215761	DPIPWE
Great Forester River off East Diddleum Road	H1	Great Forester - Brid	543000	5430898	DPIPWE
Great Musselroe River at New England Road	H1	Musselroe - Ansons	590124	5442336	DPIPWE
Great Musselroe River at Tebrakunna Road	H1	Musselroe - Ansons	589222	5451052	DPIPWE
Groom River at Anchor Road	H1	George	584879	5434980	DPIPWE
Hogarth Rivulet at end of Falls Road	H1	Great Forester - Brid	551153	5432936	DPIPWE
Jackeys Creek downstream of Jackeys Marsh	H1	Meander	470447	5386453	DPIPWE
Lake River at Little Den	H1	Brumbys - Lake	508400	5354675	DPIPWE
Leven River at Black Marsh Road	H1	Leven	403193	5410796	DPIPWE
Leven River at Lowana Road	H1	Leven	415935	5424406	DPIPWE
Leven River at Taylors Bridge	H1	Leven	414426	5414716	DPIPWE
Liffey River upstream of Liffey	H1	Meander	481816	5385291	DPIPWE
Little Boobyalla River off Old Port Road	H1	Boobyalla - Tomahawk	575004	5459340	DPIPWE
Little Fisher River upstream of lowest road crossing	H1	Mersey	438824	5385363	Hydro Tasmania, DPIPWE
Lobster Rivulet at Parsons Road	H1	Mersey	452631	5392075	DPIPWE
Mackenzie Rivulet off Mackenzie Valley Road	H1	Great Forester - Brid	545783	5434433	DPIPWE
Macquarie River off Honeysuckle Road	H1	Macquarie	558198	5331930	DPIPWE
Meander River at Environmental Flows site	H1	Meander	469186	5386513	DPIPWE
Meander River at Falls Road	H1	Meander	464019	5382479	DPIPWE
Meander River downstream of Huntsman Dam	H1	Meander	468378	5384116	DPIPWE
Memory Creek at Upper Esk Road	H1	South Esk	558966	5416099	DPIPWE
Mersey River upstream of Lake Rowallan	H1	Mersey	431714	5367851	DPIPWE
Mountain River upstream of Trestle Creek	H1	Huon	511240	5248129	DPIPWE

HEV BIOLOGICAL CONDITION REFERENCE SITES	Hydrological region	Catchment	Easting	Northing	Data Provider
Musselroe Creek at Tebrakunna Road	H1	Musselroe - Ansons	587800	5450600	DPIPWE
New River at New River Road	H1	Ringarooma	569916	5429275	DPIPWE
Nicholls Rivulet at Smiths Road	H1	Huon	512675	5225368	DPIPWE
Nile River at Lilyburn Bridge	H1	South Esk	538191	5397254	DPIPWE
North Esk River at Ben Nevis Gate	H1	North Esk	544320	5415758	DPIPWE
North West Bay River at Betts Road	H1	Derwent Estuary - Bruny	516853	5244216	DPIPWE
North West Bay River off Pipeline Track	H1	Derwent Estuary - Bruny	514996	5247500	DPIPWE
Pipers River at Underwood	H1	Pipers	517097	5428648	NRM North, DPIPWE
Plummers Creek at Prices Hill Road	H1	Tasman	562257	5225717	DPIPWE
Powers Rivulet at Terryvale Road	H1	George	590925	5426350	DPIPWE
Ransom River at Murdochs Road	H1	George	588118	5434931	DPIPWE
Redwater Creek off Sheffield Road	H1	Mersey	449073	5419906	DPIPWE
Ringarooma River at Trenah	H1	Ringarooma	557357	5426735	NRM North, DPIPWE
Rocky Creek at Lilydale	H1	Pipers	518138	5432719	NRM North
Scamander River at Hogans Road	H1	Scamander - Douglas	591640	5416464	DPIPWE
Snug River at Snug Tiers Road	H1	Derwent Estuary - Bruny	519231	5231168	DPIPWE
South Esk River at Cokers Road	H1	South Esk	559999	5414227	DPIPWE
Tomahawk River off Banca Road	H1	Boobyalla - Tomahawk	564058	5464452	DPIPWE
Tower Rivulet at Pepper Hill Road	H1	South Esk	572257	5392085	DPIPWE
Weld River at Frome Road	H1	Ringarooma	573877	5446198	NRM North
Weld River at Moorina	H1	Ringarooma	573188	5446974	DPIPWE
Winter Brook off Loongana Road	H1	Leven	417658	5414206	DPIPWE
Wyniford River at Tebrakunna Road	H1	Ringarooma	580723	5450879	DPIPWE
Apsley River at Rosendale Road	H2	Swan - Apsley	602948	5365036	DPIPWE
Cygnet River at McKays Road	H2	Swan - Apsley	572716	5356333	DPIPWE
Lisdillon Rivulet at Tasman Highway (below weir)	H2	Little Swanport	582230	5318067	DPIPWE
Sandspit River at Rheban Road	H2	Prosser	573779	5277745	DPIPWE
West Swan River at Waters Meeting	H2	Swan - Apsley	588937	5357661	DPIPWE

HEV BIOLOGICAL CONDITION REFERENCE SITES	Hydrological region	Catchment	Easting	Northing	Data Provider
West Swan River downstream of Jam Creek	H2	Swan - Apsley	579022	5360499	DPIPWE
Andrew River at Kelly Basin Road	H3	Gordon - Franklin	385852	5324896	Cradle Coast NRM
Argent River at Murchison Highway	H3	Pieman	368505	5370303	DPIPWE
Arve River at Arve Ford	H3	Huon	485596	5231706	DPIPWE
Arve River at Arve Road	H3	Huon	484318	5221548	DPIPWE
Big Rocky Creek at Heemskirk Road	H3	Pieman	341552	5371582	Cradle Coast NRM
Broad River upstream of Repulse Dam	H3	Upper Derwent	472031	5293133	DPIPWE
Castle Forbes Rivulet at Bay Link	H3	Huon	495884	5226433	DPIPWE
Cataract River upstream of Styx River confluence	H3	Lower Derwent	484134	5268011	DPIPWE
Churchill Creek at Cooks Track	H3	Upper Derwent	454157	5271151	DPIPWE
Clarence River at Lyell Highway	H3	Upper Derwent	444972	5335172	DPIPWE
Coldstream River at Huskisson Drive	H3	Pieman	377189	5403425	DPIPWE
Cook Creek at Picton Road	H3	Huon	472481	5217948	DPIPWE
Creekton Rivulet at Creekton Road	H3	Huon	491262	5197725	DPIPWE
Crystal Creek at South Weld Road	H3	Huon	472852	5236179	DPIPWE
Denison River downstream of Maxwell River	H3	Gordon - Franklin	407329	5272883	Hydro Tasmania
Denison River upstream of Truchanas Reserve	H3	Gordon - Franklin	417533	5283131	Hydro Tasmania
D'Entrecasteaux River at South Cape Road	H3	Huon	489972	5182899	DPIPWE
Derwent River downstream of Lake St Clair	H3	Upper Derwent	435246	5335500	DPIPWE
Dundas River at Dundas Road	H3	King - Henty	368591	5362609	DPIPWE
Dundas River at Zeehan Highway	H3	King - Henty	367544	5360115	DPIPWE
Eldon River upstream of Lake Burbury	H3	King - Henty	391829	5348195	DPIPWE
Esperance River at Esperance River Road	H3	Huon	486690	5211058	DPIPWE
Esperance Trib off Esperance River Road	H3	Huon	487767	5210399	DPIPWE
Ewart Creek at Zeehan Highway	H3	King - Henty	372504	5351735	DPIPWE
Farm Creek at Pieman Road	H3	Pieman	382893	5381138	DPIPWE
Farmhouse Creek at Picton Road	H3	Huon	473053	5213402	DPIPWE
Farrell Rivulet at Zeehan Highway	H3	King - Henty	370783	5355641	DPIPWE

HEV BIOLOGICAL CONDITION REFERENCE SITES	Hydrological region	Catchment	Easting	Northing	Data Provider
Florentine River at Florentine Road	H3	Upper Derwent	459262	5300871	DPIPWE
Florentine River at Tiger Road	H3	Upper Derwent	454404	5284874	DPIPWE
Franklin River at Flat Island	H3	Gordon - Franklin	398065	5296913	Hydro Tasmania
Franklin River downstream of Blackman's Bend	H3	Gordon - Franklin	398697	5291325	Hydro Tasmania
Franklin River at Lyell Highway	H3	Gordon - Franklin	419072	5325870	DPIPWE
Gordon River at Devils Teapot	H3	Gordon - Franklin	396931	5282671	Hydro Tasmania
Gordon River downstream of Denison River	H3	Pieman	402998	5271421	Hydro Tasmania
Gordon River downstream of Olga River	H3	Gordon - Franklin	398503	5277515	Hydro Tasmania
Gordon River upstream of Smith River	H3	Gordon - Franklin	402168	5273558	Hydro Tasmania
Halls Creek at Mt Jukes Road	H3	King - Henty	377488	5334419	DPIPWE
Hatfield River at Huskisson Drive	H3	Pieman	376092	5393298	DPIPWE
Heazelwood River at Waratah Road	H3	Pieman	358691	5407496	DPIPWE
Heazlewood River at Mt Cleveland Road	H3	Pieman	361728	5410753	DPIPWE
Horton River at Sumac Road	H3	Arthur	334550	5432450	DPIPWE
Hot Springs Creek at North Lune Road	H3	Huon	488696	5194540	DPIPWE
Humboldt River at Newbury Road	H3	Lower Derwent	472043	5268621	DPIPWE
Isabella Creek off South Weld Road	H3	Huon	472121	5236756	DPIPWE
James River upstream of Lake Augusta	H3	Ouse	456749	5368196	DPIPWE
Jane River upstream of Acheron River	H3	Gordon - Franklin	408192	5300538	Hydro Tasmania
Judds Creek upstream of Judbury	H3	Huon	494732	5240903	DPIPWE
Junee River at Junee Road	H3	Lower Derwent	467364	5268037	DPIPWE
Keoghs Creek at Arve Road	H3	Huon	483225	5222371	DPIPWE
Kermandie River at Oigles Road	H3	Huon	490143	5218600	DPIPWE
Kroanna Creek at Manuka Road	H3	Huon	473537	5228854	DPIPWE
Lindsay River at Heemskirk Road	H3	Arthur	331022	5422951	Cradle Coast NRM
Lost Creek at Zeplin Road	H3	King - Henty	362113	5342708	DPIPWE
Maxwell River upstream of Denison River	H3	Gordon - Franklin	409109	5276149	Hydro Tasmania
Mesa Creek at North Lune Road	H3	Huon	488033	5193606	DPIPWE

HEV BIOLOGICAL CONDITION REFERENCE SITES	Hydrological region	Catchment	Easting	Northing	Data Provider
Nelson Bay River at Rebecca Road	H3	Nelson Bay	317627	5437604	Cradle Coast NRM
Nelson River at Lyell Highway	H3	King - Henty	395162	5337915	DPIPWE
Newell Creek at Mt Jukes Road	H3	King - Henty	379373	5331210	Cradle Coast NRM
Nive River upstream of Pine Tier Lagoon (Buggs Road)	H3	Upper Derwent	456090	5341098	DPIPWE
Ouse River upstream of Lake Augusta	H3	Ouse	462339	5368782	DPIPWE
Peak Rivulet off Peak Rivulet Road	H3	Huon	491391	5203972	DPIPWE
Pearl Creek at Zeehan Highway	H3	King - Henty	379249	5342862	DPIPWE
Picton River at Riveaux Road	H3	Huon	477094	5227142	DPIPWE
Picton River downstream of Farmhouse Creek	H3	Huon	474241	5213646	DPIPWE
Pine River upstream of Pine Tier Lagoon (Gowan Brae Road)	H3	Upper Derwent	456791	5342254	DPIPWE
Piney Creek at Heemskirk Road	H3	Pieman	355223	5367468	DPIPWE
Plenty River at Leesons Road	H3	Lower Derwent	494515	5259755	DPIPWE
Plenty River tributary at Plenty Valley Rd	H3	Lower Derwent	486103	5252027	DPIPWE
Plenty River upstream of Stony Creek	H3	Lower Derwent	488246	5254460	DPIPWE
Princess Creek at Mt Jukes Road	H3	King - Henty	377477	5335336	DPIPWE
Puzzle River north of Russel Bridge	H3	Lower Derwent	489606	5249485	DPIPWE
Rachel Creek at Heemskirk Road	H3	Nelson Bay	312870	5436946	DPIPWE
Repulse River upstream of Repulse Dam (Dawsons Rd)	H3	Upper Derwent	469439	5293300	DPIPWE
Russell River at Russell Pimple	H3	Huon	482687	5245675	DPIPWE
Russell River at Russell Road	H3	Huon	477979	5250218	DPIPWE
Serpentine Rivulet upstream of Serpentine Dam	H3	Upper Derwent	459525	5336476	DPIPWE
South Creek upstream of Kermandie River	H3	Huon	490405	5218515	DPIPWE
South Eldon River upstream of Lake Burbury	H3	King - Henty	392107	5347933	DPIPWE
South Styx River upstream of Styx River confluence	H3	Lower Derwent	468591	5259095	DPIPWE
Stanley River at Pieman Road	H3	Pieman	357778	5381532	Cradle Coast NRM, DPIPWE
Stony Creek at Plenty Valley Road	H3	Lower Derwent	488186	5254639	DPIPWE
Styx River at Cataract Road	H3	Lower Derwent	484578	5267776	DPIPWE
Styx River at Styx Road	H3	Lower Derwent	468577	5259156	DPIPWE

HEV BIOLOGICAL CONDITION REFERENCE SITES	Hydrological region	Catchment	Easting	Northing	Data Provider
Tomalah Creek at Manuka Road	H3	Huon	473078	5229273	DPIPWE
Tully River at Rayner Road	H3	King - Henty	359131	5342323	DPIPWE
Tyenna River at Florentine Road	H3	Lower Derwent	465915	5266163	DPIPWE
Un-named Tributary upstream of Little Florentine River (Cooks Track)	H3	Upper Derwent	453062	5269339	DPIPWE
Warra Creek at Warra Road	H3	Huon	476072	5231119	DPIPWE
West Queen River at Lake Margaret Road	H3	King - Henty	380547	5342406	DPIPWE
Whyte River upstream of Luina	H3	Pieman	365675	5408154	DPIPWE
Yolande River at Zeehan Highway	H3	King - Henty	376637	5347128	DPIPWE
Black River at Newhaven Road	H4	Black - Detention	363562	5460835	DPIPWE
Blythe River at South Riana Road	H4	Blythe	410395	5434591	DPIPWE
Blythe River off Blythe Road	H4	Blythe	403710	5425700	DPIPWE
Detention River at Newhaven Road	H4	Black - Detention	372943	5464673	Cradle Coast NRM, DPIPWE
Dip River at Rabalga Track	H4	Black - Detention	368811	5449615	Cradle Coast NRM
Duck River at Wedge Plains Road	H4	Duck	347156	5458241	Cradle Coast NRM
Farnhams Creek at Farnhams Creek Road	H4	Montagu	327558	5473539	DPIPWE
Flowerdale River at Meunna Road	H4	Inglis	376018	5446898	Cradle Coast NRM, DPIPWE
Hebe River at Myalla Road	H4	Inglis	372719	5454125	Cradle Coast NRM, DPIPWE
Holder Rivulet at Holder Road	H4	Arthur	351875	5450511	DPIPWE
Jessie River upstream of Inglis River	H4	Inglis	382222	5447500	DPIPWE
Keith River at Farquhars Road	H4	Arthur	369117	5439077	DPIPWE
Lawson Rivulet at Tayatea Road	H4	Arthur	346590	5446338	DPIPWE
Montagu River at Roger River Road	H4	Montagu	332255	5451521	Cradle Coast NRM, DPIPWE
Providence Creek at Holder Road	H4	Arthur	356185	5449705	DPIPWE
Rapid River at Rapid River Road	H4	Arthur	340579	5442322	DPIPWE
Stephens Rivulet upstream of Arthur River	H4	Arthur	328641	5447217	DPIPWE

SMEV BIOLOGICAL CONDITION REFERENCE SITES	Hydrological region	Catchment	Easting	Northing	Data Provider
Allens Rivulet at Kaoota Road	H1	Derwent Estuary - Bruny	514550	5237445	DPIPWE
Ben Lomond Rivulet at Nile Road	H1	South Esk	540189	5377852	NRM North
Black River at Spion Kop Road	H4	Black - Detention	356422	5470910	DPIPWE
Blackman River at Old Tier Road (pre dam)	H1	Macquarie	528604	5331841	DPIPWE
Brushy Rivulet at Birralee Road	H1	Meander	486314	5408199	DPIPWE
Buffalo Brook at Bonneys Plains Road	H1	South Esk	551400	5372800	DPIPWE
Cam River at Oonah Road	H4	Cam	384086	5435232	Cradle Coast NRM
Cascade River off Tasman Highway	H1	Ringarooma	567603	5444118	NRM North
Comet Creek below mine	H3	King - Henty	370805	5362455	DPIPWE
Coombes Rivulet at Huon Road	H1	Derwent Estuary - Bruny	515740	5242104	DPIPWE
Dee River at Father of Marshes Road	H3	Upper Derwent	468450	5313124	DPIPWE
Derwent River downstream of Lake St Clair	H3	Upper Derwent	435246	5335500	DPIPWE
Dip River at Gibsons Creek Road	H4	Black - Detention	357720	5466957	DPIPWE
Duck River at Maguires Road	H4	Duck	342123	5458113	DPIPWE
Emu River at Upper Natone Road (near Hampshire)	H4	Emu	398956	5430557	Cradle Coast NRM, DPIPWE
Fisher River upstream of Fisher Power Station	H1	Mersey	439188	5385987	Hydro Tasmania
Ford River at Upper Blessington	H1	North Esk	547868	5409034	NRM North, DPIPWE
Garden Island Creek at Garden Island Creek	H1	Huon	512525	5212950	DPIPWE
Glen Dhu Rivulet at Molesworth Road	H1	Lower Derwent	510002	5262165	DPIPWE
Glen Morriston Rivulet at Moulton	H1	Macquarie	547210	5339803	DPIPWE
Great Forester River at South Springfield	H1	Great Forester - Brid	542442	5433510	DPIPWE
Hellyer River at Guilford Link Road	H4	Arthur	389498	5418390	Cradle Coast NRM, DPIPWE
Henty River at Zeehan Highway	H3	King - Henty	373412	5349755	DPIPWE
Hogarth Rivulet at Cuckoo Road (upper)	H1	Great Forester - Brid	548775	5437100	DPIPWE
Huskisson River at Huskisson River Road	H3	Pieman	375438	5392869	DPIPWE
Huskisson River at Pieman Road	H3	Pieman	370282	5378733	DPIPWE
Kellaways Creek at Halls Track Road	H1	Huon	509566	5234279	DPIPWE
Lachlan River upstream of Lachlan	H1	Lower Derwent	502354	5254015	DPIPWE

SMEV BIOLOGICAL CONDITION REFERENCE SITES	Hydrological region	Catchment	Easting	Northing	Data Provider
Leven River at Marshalls Bridge	H1	Leven	415700	5427800	DPIPWE
Levert Rivulet at Wolfes Road	H1	Derwent Estuary - Bruny	519170	5243850	DPIPWE
Little Denison River at Denison Road	H3	Huon	486169	5239183	DPIPWE
Macquarie River at Tooms Lake Road	H1	Macquarie	547918	5331932	DPIPWE
Meander River at Cheshunt Bridge	H1	Meander	467741	5391618	DPIPWE
Meander River at Environmental Flows site (post dam)	H1	Meander	469186	5386513	DPIPWE
Meander River at Meander	H1	Meander	467998	5389092	DPIPWE
Medway River at Black Marsh Road	H1	Leven	400716	5412294	DPIPWE
Mersey River at C138 Road	H1	Mersey	435297	5397050	DPIPWE
Mersey River at Dogs Head Hill	H1	Mersey	440501	5403209	DPIPWE
Mersey River upstream of Union Bridge	H1	Mersey	444476	5403981	DPIPWE
Mountain River at Mountain River Road	H1	Huon	510982	5246089	DPIPWE
Musselboro Creek at Burns Creek Road	H1	North Esk	537666	5409784	NRM North
New River at Singline Road	H1	Ringarooma	567588	5431367	NRM North
Nile River at Deddington	H1	South Esk	534012	5393735	DPIPWE
Nive River at Lyell Highway	H3	Upper Derwent	455977	5332408	DPIPWE
North Esk River at Camden Road (wattle corner)	H1	North Esk	544650	5408228	DPIPWE
North George River off Linda Vale Rd (Binns Rd)	H1	George	579559	5431516	DPIPWE
North West Bay River at Longley Park	H1	Derwent Estuary - Bruny	515903	5242148	DPIPWE
North West Bay River at River Bend Road	H1	Derwent Estuary - Bruny	516635	5243103	DPIPWE
Ouse River at Marlborough Highway	H3	Ouse	470315	5351254	Hydro Tas, DPIPWE
Pearly Brook at Forester Road	H1	Great Forester - Brid	556665	5450984	DPIPWE
Pearly Brook at Pearly Brook Road	H1	Great Forester - Brid	553746	5454062	DPIPWE
Quamby Brook at Golden Valley	H1	Meander	476592	5391700	DPIPWE
Quamby Brook at Osmaston Road	H1	Meander	476976	5399306	DPIPWE
Roger River at Buffs Road	H4	Duck	333304	5452525	DPIPWE
Russell River at Denison Road	H3	Huon	488531	5240972	DPIPWE
Sassafras Creek at Howes Road	H1	Mersey	447141	5398275	DPIPWE

SMEV BIOLOGICAL CONDITION REFERENCE SITES	Hydrological region	Catchment	Easting	Northing	Data Provider
Scamander River at Upper Scamander	H1	Scamander - Douglas	599742	5411400	NRM North
Sorell Creek at Collinsvale	H1	Lower Derwent	515430	5256342	DPIPWE
South Esk River U/S of Griffin Road Picnic Area	H1	South Esk	569734	5408778	DPIPWE
St Patricks River at Corkerys Road	H1	North Esk	534092	5428560	NRM North, DPIPWE
St Patricks River at East Diddleum Road	H1	North Esk	538923	5425931	NRM North, DPIPWE
St Pauls River upstream of Royal George	H1	South Esk	580913	5368960	DPIPWE
Stitt River at Rosebery	H3	Pieman	378975	5370600	Cradle Coast NRM
Swan River at Tasman Highway	H2	Swan - Apsley	589420	5349996	DPIPWE
Thomson Creek at Allens Rivulet Road	H1	Derwent Estuary - Bruny	516463	5237958	DPIPWE
Tyenna River at Gordon River Road	H3	Lower Derwent	477952	5274528	DPIPWE
Wallastonite Creek at Upper Natone Road	H4	Emu	399683	5430211	DPIPWE
Wey River at Wey Road	H4	Arthur	393188	5418498	DPIPWE
Wilmot River at Spellmans Road	H1	Forth - Wilmot	430048	5422011	Hydro Tas, DPIPWE
Wilson River at Pieman Road	H3	Pieman	364147	5381600	DPIPWE

Appendix D: HEV and SMEV reference sites for Estuarine waters

The sites in the following lists were those used in the derivation of the DGVs for estuarine aquatic ecosystems.

HEV Estuary Reference sites and location	Flushing Class	Estuary	Latitude	Longitude	Data Provider
Observatory - Middle	well flushed	Payne Bay	-43.225092	145.92969	CSIRO
Earle - Lower	well flushed	Payne Bay	-43.270037	145.931627	CSIRO
Davey - Upper	well flushed	Payne Bay	-43.189312	145.919038	CSIRO
Turnbull - Lower	Poorly Flushed	Bathurst Harbour	-43.333539	145.995113	CSIRO
Nicholls - Lower	Poorly Flushed	Bathurst Harbour	-43.344402	146.028822	CSIRO
Farrell - Middle	Poorly Flushed	Bathurst Harbour	-43.341034	146.085475	CSIRO
Swan - Middle	Poorly Flushed	Bathurst Harbour	-43.330712	146.212935	CSIRO
Old R - Upper	Poorly Flushed	Bathurst Harbour	-43.316689	146.237891	CSIRO
Rowitta - Upper	Poorly Flushed	Bathurst Harbour	-43.335267	146.196131	CSIRO

HEV Estuary Reference sites and location	Flushing Class	Estuary	Latitude	Longitude	Data Provider
Chink - Upper	Poorly Flushed	Bathurst Harbour	-43.340377	146.173064	CSIRO
White - Upper	Poorly Flushed	Bathurst Harbour	-43.345598	146.154122	CSIRO
Platypus - Upper	Poorly Flushed	Bathurst Harbour	-43.352165	146.129957	CSIRO
RMCA1 - Lower	well flushed	Catamaran	43.55391667	146.8898167	IMAS
RMCA2 - Lower	well flushed	Catamaran	43.554	146.8867	IMAS
RMCA3 - Middle	well flushed	Catamaran	43.55571667	146.8848167	IMAS
RMCA4 - Middle	well flushed	Catamaran	43.55591667	146.88265	IMAS
RMCA5 - Upper	well flushed	Catamaran	43.55715	146.87945	IMAS
RMCA6 - Upper	well flushed	Catamaran	43.55798333	146.879	IMAS
RMNB2 - Lower	Open/Closed	Nelson Bay	41.13948333	144.6791833	IMAS
RMNB3 - Lower	Open/Closed	Nelson Bay	41.13916667	144.6805	IMAS
RMNB4 - Middle	Open/Closed	Nelson Bay	41.13805	144.68135	IMAS

SMEV Estuary Reference sites and location	Flushing Class	Estuary	Latitude	Longitude	Data Provider
A1 - Upper	Poorly Flushed	Ansons	41.05638333	148.2327583	IMAS
A10 - Middle	Poorly Flushed	Ansons	41.03938611	148.2773861	IMAS
A11 - Lower	Poorly Flushed	Ansons	41.04936667	148.2860028	IMAS
A12 - Lower	Poorly Flushed	Ansons	41.06166111	148.2952389	IMAS
A2 - Upper	Poorly Flushed	Ansons	41.05446111	148.2389556	IMAS
A3 - Upper	Poorly Flushed	Ansons	41.05606184	148.2341015	IMAS
A4 - Upper	Poorly Flushed	Ansons	41.05696609	148.2394128	IMAS
A5 - Upper	Poorly Flushed	Ansons	41.05398753	148.2422024	IMAS
A6 - Upper	Poorly Flushed	Ansons	41.05436111	148.2501694	IMAS
A7 - Upper	Poorly Flushed	Ansons	41.04948333	148.2597333	IMAS
A8 - Middle	Poorly Flushed	Ansons	41.04811111	148.26965	IMAS
A9 - Middle	Poorly Flushed	Ansons	41.04686944	148.2776667	IMAS
AB1 - Lower	Poorly Flushed	Ansons	42.06164722	148.2952194	IMAS
AB2 - Middle	Poorly Flushed	Ansons	42.03954167	148.2772389	IMAS
AB3 - Upper	Poorly Flushed	Ansons	42.04953889	148.2597167	IMAS
AB4 - Upper	Poorly Flushed	Ansons	42.05464444	148.2329778	IMAS
RMAB1 - Middle	Poorly Flushed	Ansons	41.04805	148.2787667	IMAS
RMABP10 - Upper	Poorly Flushed	Ansons	41.05038333	148.2553	IMAS
RMABP11 - Middle	Poorly Flushed	Ansons	41.04803333	148.2817667	IMAS
RMABP12 - Middle	Poorly Flushed	Ansons	41.04681667	148.26515	IMAS
RMABP2 - Upper	Poorly Flushed	Ansons	41.05588333	148.24965	IMAS
RMABP3 - Middle	Poorly Flushed	Ansons	41.04976667	148.26315	IMAS
RMABP4 - Middle	Poorly Flushed	Ansons	41.04918333	148.2714	IMAS
RMABP5 - Middle	Poorly Flushed	Ansons	41.03901667	148.2710667	IMAS
RMABP6 - Lower	Poorly Flushed	Ansons	41.06103333	148.2920167	IMAS
RMABP7 - Upper	Poorly Flushed	Ansons	41.05575	148.2333833	IMAS
RMABP8 - Upper	Poorly Flushed	Ansons	41.05458333	148.2423167	IMAS
RMABP9 - Upper	Poorly Flushed	Ansons	41.05513333	148.25015	IMAS

SMEV Estuary Reference sites and location	Flushing Class	Estuary	Latitude	Longitude	Data Provider
JBARL1 - Lower	Poorly Flushed	Arthur	41.05289	144.66508	IMAS
JBARL2 - Middle	Poorly Flushed	Arthur	41.04968	144.69378	IMAS
JBARM1 - Middle	Poorly Flushed	Arthur	41.05645	144.72594	IMAS
JBARM2 - Middle	Poorly Flushed	Arthur	41.0588	144.74704	IMAS
JBARU1 - Upper	Poorly Flushed	Arthur	41.07044	144.76381	IMAS
JBARU2 - Upper	Poorly Flushed	Arthur	41.0758	144.76624	IMAS
2 - Lower	Well Flushed	Black/Dip	40.83881	145.3123	IMAS
5 - Middle	Well Flushed	Black/Dip	40.84369	145.3092	IMAS
8 - Middle	Well Flushed	Black/Dip	40.84633	145.3026	IMAS
AHBLL2 - Lower	Well Flushed	Black/Dip	40.839481	145.3111422	IMAS
AHBLL3 - Middle	Well Flushed	Black/Dip	40.842796	145.3094793	IMAS
AHBLLOW3 - Lower	Well Flushed	Black/Dip	40.83843	145.312221	IMAS
AHBLU2 - Middle	Well Flushed	Black/Dip	40.84741	145.3056977	IMAS
AHBLU3 - Middle	Well Flushed	Black/Dip	40.847168	145.3014975	IMAS
BR1 - Lower	Well Flushed	Black/Dip	40.83779722	145.313975	IMAS
BU1 - Middle	Well Flushed	Black/Dip	40.846455	145.3092487	IMAS
R1 - Upper	Well Flushed	Black/Dip	40.84853	145.2925	IMAS
R2 - Middle	Well Flushed	Black/Dip	40.84610556	145.3091333	IMAS
R3 - Middle	Well Flushed	Black/Dip	40.84693611	145.3014972	IMAS
R4 - Upper	Well Flushed	Black/Dip	40.84823333	145.2942861	IMAS
RMBL2 - Lower	Well Flushed	Black/Dip	40.83891667	145.3124	IMAS
RMBL3 - Middle	Well Flushed	Black/Dip	40.84186667	145.3094167	IMAS
RMBL4 - Middle	Well Flushed	Black/Dip	40.84658333	145.3073	IMAS
RMBL5 - Middle	Well Flushed	Black/Dip	40.84578333	145.3029167	IMAS
RMBL6 - Middle	Well Flushed	Black/Dip	40.84651667	145.3017167	IMAS
RMCB1 - Lower	Poorly Flushed	Cloudy	43.43495	147.2009667	IMAS
RMCB2 - Lower	Poorly Flushed	Cloudy	43.43181667	147.2021333	IMAS
RMCB3 - Middle	Poorly Flushed	Cloudy	43.43098333	147.2298833	IMAS

SMEV Estuary Reference sites and location	Flushing Class	Estuary	Latitude	Longitude	Data Provider
RMCB5 - Middle	Poorly Flushed	Cloudy	43.43215	147.2175	IMAS
RMCB6 - Middle	Poorly Flushed	Cloudy	43.43335	147.2119	IMAS
RMCB7 - Middle	Poorly Flushed	Cloudy	43.42876667	147.2070833	IMAS
RMCBP1 - Middle	Poorly Flushed	Cloudy	43.43273333	147.20915	IMAS
RMCBP2 - Middle	Poorly Flushed	Cloudy	43.43375	147.21135	IMAS
RMCBP3 - Middle	Poorly Flushed	Cloudy	43.43368333	147.2199	IMAS
RMCBP4 - Middle	Poorly Flushed	Cloudy	43.43173333	147.23115	IMAS
RMCBP5 - Middle	Poorly Flushed	Cloudy	43.42913333	147.23555	IMAS
RMCBP6 - Middle	Poorly Flushed	Cloudy	43.4269	147.2384667	IMAS
RMCC1 - Lower	Poorly Flushed	Cockle	43.58245	146.8918667	IMAS
RMCC2 - Lower	Poorly Flushed	Cockle	43.58191667	146.888	IMAS
RMCC3 - Middle	Poorly Flushed	Cockle	43.582	146.8859833	IMAS
RMCC4 - Middle	Poorly Flushed	Cockle	43.5838	146.8831833	IMAS
RMCC5 - Upper	Poorly Flushed	Cockle	43.58585	146.8786167	IMAS
RMCC6 - Upper	Poorly Flushed	Cockle	43.58688333	146.8764	IMAS
RMCCP1 - Lower	Poorly Flushed	Cockle	43.58246667	146.8926	IMAS
RMCCP2 - Lower	Poorly Flushed	Cockle	43.5816	146.8873667	IMAS
RMCCP3 - Middle	Poorly Flushed	Cockle	43.58285	146.8835333	IMAS
RMCCP4 - Middle	Poorly Flushed	Cockle	43.58508333	146.8813833	IMAS
RMCCP5 - Upper	Poorly Flushed	Cockle	43.58681667	146.8768	IMAS
RMCCP6 - Upper	Poorly Flushed	Cockle	43.5879	146.8741333	IMAS
RMDR1 - Lower	Open / Closed	Douglas	41.78106667	148.2709667	IMAS
RMDR2 - Middle	Open / Closed	Douglas	41.77716667	148.2665667	IMAS
RMDR3 - Middle	Open / Closed	Douglas	41.77858333	148.2690333	IMAS
RMDR4 - Middle	Open / Closed	Douglas	41.77775	148.2679333	IMAS
RMDR5 - Middle	Open / Closed	Douglas	41.77736667	148.2672167	IMAS
RMDR6 - Middle	Open / Closed	Douglas	41.77766667	148.2664667	IMAS
RMDRP1 - Lower	Open / Closed	Douglas	41.7803	148.2702833	IMAS

SMEV Estuary Reference sites and location	Flushing Class	Estuary	Latitude	Longitude	Data Provider
RMDRP10 - Middle	Open / Closed	Douglas	41.7774	148.2678	IMAS
RMDRP11 - Middle	Open / Closed	Douglas	41.77766667	148.2667833	IMAS
RMDRP12 - Middle	Open / Closed	Douglas	41.7781	148.2666667	IMAS
RMDRP2 - Lower	Open / Closed	Douglas	41.7806	148.2709833	IMAS
RMDRP3 - Middle	Open / Closed	Douglas	41.77905	148.26935	IMAS
RMDRP4 - Middle	Open / Closed	Douglas	41.77786667	148.2679833	IMAS
RMDRP5 - Middle	Open / Closed	Douglas	41.77728333	148.2669667	IMAS
RMDRP6 - Middle	Open / Closed	Douglas	41.7786	148.2665667	IMAS
RMDRP7 - Middle	Open / Closed	Douglas	41.77813333	148.2694	IMAS
RMDRP8 - Lower	Open / Closed	Douglas	41.77958333	148.2703167	IMAS
RMDRP9 - Lower	Open / Closed	Douglas	41.78093333	148.2710667	IMAS
RMEL1 - Lower	Open / Closed	Earlham	42.65465	147.9559667	IMAS
RMEL2 - Middle	Open / Closed	Earlham	42.65331667	147.9489	IMAS
RMEL3 - Middle	Open / Closed	Earlham	42.65265	147.9459	IMAS
RMEL4 - Middle	Open / Closed	Earlham	42.65011667	147.9397667	IMAS
RMEL5 - Upper	Open / Closed	Earlham	42.64956667	147.9383833	IMAS
RMEL6 - Upper	Open / Closed	Earlham	42.64823333	147.9352833	IMAS
RMELP1 - Lower	Open / Closed	Earlham	42.65306667	147.9567333	IMAS
RMELP10 - Upper	Open / Closed	Earlham	42.64976667	147.9382333	IMAS
RMELP11 - Upper	Open / Closed	Earlham	42.64773333	147.9339167	IMAS
RMELP12 - Upper	Open / Closed	Earlham	42.64775	147.9331833	IMAS
RMELP2 - Lower	Open / Closed	Earlham	42.6545	147.9524	IMAS
RMELP3 - Middle	Open / Closed	Earlham	42.65258333	147.9459167	IMAS
RMELP4 - Middle	Open / Closed	Earlham	42.65325	147.9416667	IMAS
RMELP5 - Upper	Open / Closed	Earlham	42.64978333	147.9391333	IMAS
RMELP6 - Upper	Open / Closed	Earlham	42.64823333	147.9351333	IMAS
RMELP7 - Lower	Open / Closed	Earlham	42.65495	147.95375	IMAS
RMELP8 - Middle	Open / Closed	Earlham	42.65363333	147.9480667	IMAS

SMEV Estuary Reference sites and location	Flushing Class	Estuary	Latitude	Longitude	Data Provider
RMELP9 - Middle	Open / Closed	Earlham	42.65258333	147.9410333	IMAS
RMEB3 - Middle	Well Flushed	East	40.7943	145.2734167	IMAS
RMEB4 - Middle	Well Flushed	East	40.79638333	145.2803167	IMAS
RMEB5 - Upper	Well Flushed	East	40.80038333	145.2778333	IMAS
RMEB6 - Upper	Well Flushed	East	40.79975	145.2800167	IMAS
RMLM1 - Lower	Poorly Flushed	Little Musselroe	40.76473333	148.03555	IMAS
RMLM2 - Lower	Poorly Flushed	Little Musselroe	40.76631667	148.03415	IMAS
RMLM3 - Middle	Poorly Flushed	Little Musselroe	40.76845	148.0386833	IMAS
RMLM4 - Middle	Poorly Flushed	Little Musselroe	40.77168333	148.0407667	IMAS
RMLM5 - Upper	Poorly Flushed	Little Musselroe	40.77361667	148.0419167	IMAS
RMLM6 - Upper	Poorly Flushed	Little Musselroe	40.77446667	148.0440333	IMAS
RMLMP1 - Lower	Poorly Flushed	Little Musselroe	40.76201667	148.0364333	IMAS
RMLMP10 - Middle	Poorly Flushed	Little Musselroe	40.77138333	148.0407167	IMAS
RMLMP11 - Upper	Poorly Flushed	Little Musselroe	40.77385	148.04205	IMAS
RMLMP12 - Upper	Poorly Flushed	Little Musselroe	40.77473333	148.0451333	IMAS
RMLMP2 - Lower	Poorly Flushed	Little Musselroe	40.76458333	148.0362667	IMAS
RMLMP3 - Lower	Poorly Flushed	Little Musselroe	40.7663	148.0354167	IMAS
RMLMP4 - Middle	Poorly Flushed	Little Musselroe	40.768	148.0379333	IMAS
RMLMP5 - Middle	Poorly Flushed	Little Musselroe	40.76956667	148.0411167	IMAS
RMLMP6 - Upper	Poorly Flushed	Little Musselroe	40.77365	148.0419167	IMAS
RMLMP7 - Lower	Poorly Flushed	Little Musselroe	40.76453333	148.03595	IMAS
RMLMP8 - Lower	Poorly Flushed	Little Musselroe	40.7665	148.0345667	IMAS
RMLMP9 - Middle	Poorly Flushed	Little Musselroe	40.76896667	148.0400333	IMAS
NTML1 - Upper	Poorly Flushed	Moulting	42.0037	148.16016	IMAS
NTML2 - Upper	Poorly Flushed	Moulting	41.99498	148.24567	IMAS
NTML3 - Middle	Poorly Flushed	Moulting	42.04905	148.17033	IMAS
NTML4 - Middle	Poorly Flushed	Moulting	42.06414	148.15302	IMAS
NTML5 - Middle	Poorly Flushed	Moulting	42.08025	148.18363	IMAS

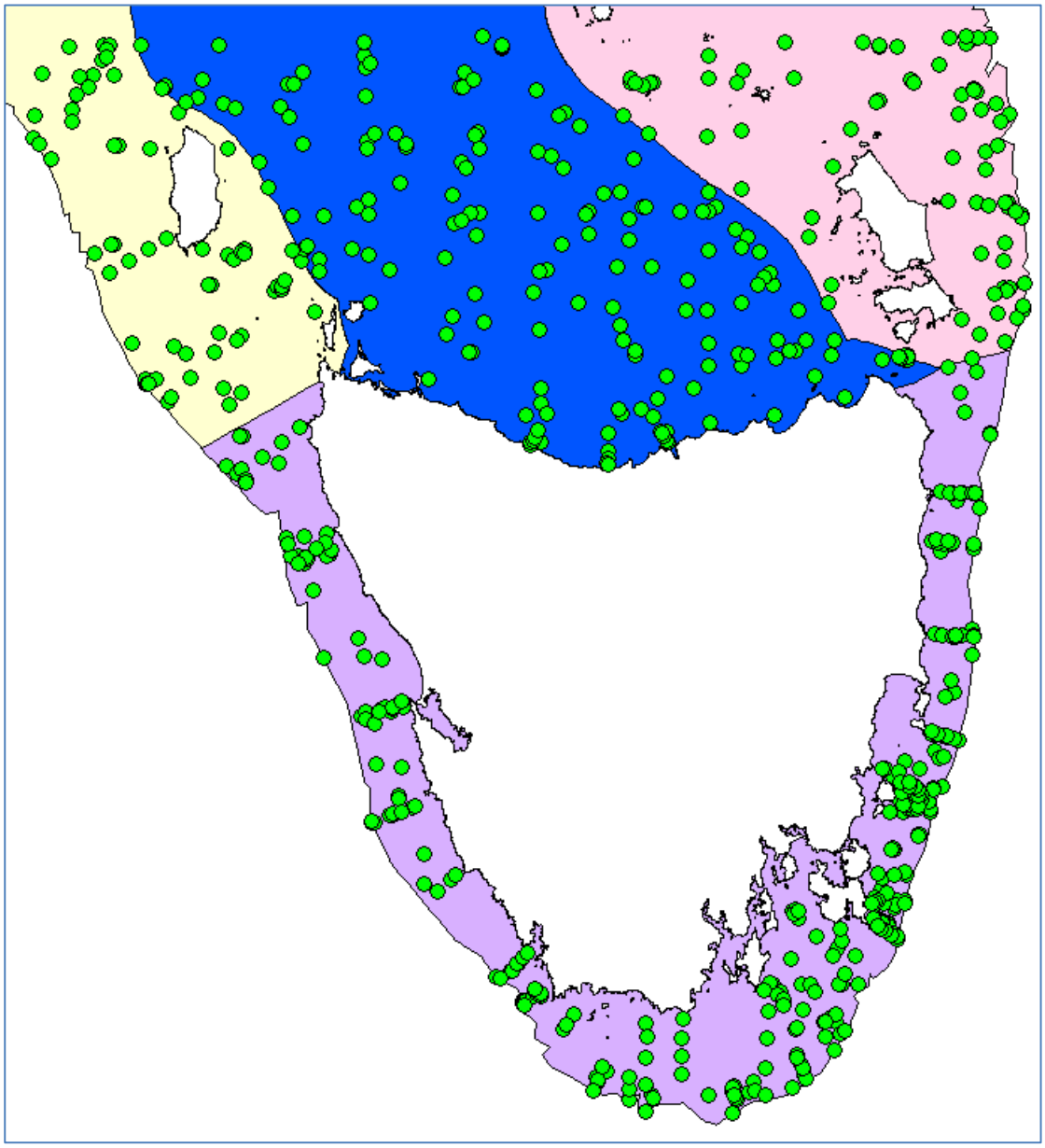
SMEV Estuary Reference sites and location	Flushing Class	Estuary	Latitude	Longitude	Data Provider
NTML6 - Middle	Poorly Flushed	Moulting	42.08197	148.20758	IMAS
R1 - Lower	Well Flushed	Ringarooma	40.86517	147.89018	IMAS
R10 - Upper	Well Flushed	Ringarooma	40.87313833	147.905185	IMAS
R11 - Upper	Well Flushed	Ringarooma	40.86964167	147.9085867	IMAS
R2 - Lower	Well Flushed	Ringarooma	40.868095	147.8884217	IMAS
R3 - Lower	Well Flushed	Ringarooma	40.87087167	147.883235	IMAS
R4 - Lower	Well Flushed	Ringarooma	40.87388833	147.88284	IMAS
R5 - Middle	Well Flushed	Ringarooma	40.87866167	147.88369	IMAS
R6 - Middle	Well Flushed	Ringarooma	40.88087333	147.8864683	IMAS
R7 - Middle	Well Flushed	Ringarooma	40.87916167	147.889535	IMAS
R8 - Middle	Well Flushed	Ringarooma	40.87721667	147.8932517	IMAS
R9 - Middle	Well Flushed	Ringarooma	40.87742333	147.9009883	IMAS
RING1 - Lower	Well Flushed	Ringarooma	40.86894722	147.8863528	IMAS
RING2 - Middle	Well Flushed	Ringarooma	40.88038056	147.8834306	IMAS
RING3 - Middle	Well Flushed	Ringarooma	40.87765278	147.9011278	IMAS
RING4 - Upper	Well Flushed	Ringarooma	40.86991389	147.9081694	IMAS
RMBO1 - Lower	Well Flushed	Ringarooma	40.87008333	147.8810833	IMAS
RMBO2 - Lower	Well Flushed	Ringarooma	40.87201667	147.88065	IMAS
RMBO3 - Middle	Well Flushed	Ringarooma	40.8755	147.8818333	IMAS
RMBO4 - Middle	Well Flushed	Ringarooma	40.88033333	147.8838833	IMAS
RMBO5 - Middle	Well Flushed	Ringarooma	40.88071667	147.8889	IMAS
RMBO6 - Middle	Well Flushed	Ringarooma	40.87776667	147.89075	IMAS
RMBOP1 - Lower	Well Flushed	Ringarooma	40.87306667	147.8812667	IMAS
RMBOP10 - Middle	Well Flushed	Ringarooma	40.87726667	147.8922	IMAS
RMBOP11 - Middle	Well Flushed	Ringarooma	40.87715	147.8956833	IMAS
RMBOP2 - Lower	Well Flushed	Ringarooma	40.87071667	147.8804	IMAS
RMBOP3 - Lower	Well Flushed	Ringarooma	40.86885	147.8820333	IMAS
RMBOP4 - Middle	Well Flushed	Ringarooma	40.87851667	147.8841833	IMAS

SMEV Estuary Reference sites and location	Flushing Class	Estuary	Latitude	Longitude	Data Provider
RMBOP5 - Middle	Well Flushed	Ringarooma	40.87913333	147.8840167	IMAS
RMBOP6 - Lower	Well Flushed	Ringarooma	40.87023333	147.8805333	IMAS
RMBOP7 - Lower	Well Flushed	Ringarooma	40.874	147.88325	IMAS
RMBOP8 - Middle	Well Flushed	Ringarooma	40.88095	147.8856667	IMAS
RMBOP9 - Middle	Well Flushed	Ringarooma	40.88021667	147.88935	IMAS

Appendix E: Reference sites for Coastal and Marine waters

In excess of 20,000 locations have been used to derive the interim DGVs for coastal and marine water aquatic ecosystems.

The figure below provides an overview of the spatial distribution of sites and the associated IMCRA 4.0.



Coastal and marine sites and Provincial Bioregions (IMCRA 4.0)

Appendix F: Reference bore sites for Groundwater

The sites in the following lists were those used in the derivation of the DGVs for groundwater aquatic ecosystems.

Bore	Region	Hydstra_ID	Easting	Northing	Data Provider
Huonville_16923	Huon and Bruny Rolling Hills	5514	504855.743	5238407.711	MRT
Chudleigh_16538	Karst	5501	455897.53	5397925.22	MRT and DPIPWE
Togari_16531	Karst	5532	322821.06	5465190.95	MRT and DPIPWE
Montagu Bore_16532	North West Basalt Plateaus and Valleys	5519	333617.52	5481097.72	MRT and DPIPWE
Trowutta Bore_16530	North West Basalt Plateaus and Valleys	5533	340208.22	5454912.73	MRT and DPIPWE
South Forest Bore_16527	North West Basalt Plateaus and Valleys	5502	351782.71	5471938.49	MRT and DPIPWE
Calder Bore_16533	North West Basalt Plateaus and Valleys	5509	390533.22	5458350.96	MRT and DPIPWE
Hampshire Bore_16534	North West Basalt Plateaus and Valleys	5513	399943.07	5437466.91	MRT and DPIPWE
Mooreville Bore_16535	North West Basalt Plateaus and Valleys	5520	404318.33	5448709.79	MRT and DPIPWE
Barrington Bore_16536	North West Basalt Plateaus and Valleys	5503	439439.64	5425824.36	MRT and DPIPWE
Spreyton Bore_18606	North West Basalt Plateaus and Valleys	5527	445373.32	5435462.415	MRT
Beulah Bore (after 2000)	North West Basalt Plateaus and Valleys	5540.2	446043.52	5409518.32	MRT and DPIPWE
Waterhouse Bore_16544	Coastal Sands	5535	541943.13	5460820.69	MRT and DPIPWE
Bicheno Bore_16548	Coastal Sands	5505	604274.98	5366692.1	MRT
Port Arthur Bore_16528	East Coast Rolling Hills	5524	566066.1	5223685.2	MRT
Buckland Bore_16551	East Coast Rolling Hills	5508	560926.87	5282615.06	MRT and DPIPWE
Little Swanport Bore_16549	East Coast Rolling Hills	5517	579353.74	5315783.66	MRT and DPIPWE
St Marys Bore_16526	North East Highlands	5528	594569.22	5396821.14	MRT and DPIPWE
Lilydale Bore_16542	North East Highlands	5516	517569.901	5432316.414	MRT
Branxholm Bore_16546	North East Highlands	5507	559942.21	5443211.49	MRT and DPIPWE
Winnaleah Bore_16547	North East Highlands	5536	568064.73	5448047.656	MRT
Hagley Bore_16540	Basins	5512	492828.36	5405391.63	MRT and DPIPWE
Cressy Bore_16541	Basins	5510	506749.33	5385874.5	MRT and DPIPWE
Ross Bore_16553	Basins	5525	541168.44	5347140.12	MRT and DPIPWE

Bore	Region	Hydstra_ID	Easting	Northing	Data Provider
Pawleena Rd Bore_16554	Basins	5522	547437.34	5264982.33	MRT and DPIPWE
Pipers River Bore_16543	Basins	5523	507017.114	5449672.26	MRT
Jetsonville Bore_16545	Basins	5515	541266.493	5448435.922	MRT
Melton Mowbray Bore_16529	Southern Midland rolling hills	5518	515294.14	5295640.17	MRT and DPIPWE
Tunnack Bore_16550	Southern Midland rolling hills	5534	537953.64	5298549.35	MRT and DPIPWE
Bothwell Bore_17772	Southern Midland rolling hills	5506	496578.021	5315623.428	MRT
Lower Snug Bore_17773	South East Plateaus and Escarpments	5526	520446.566	5229342.047	MRT
Osmaston Bore_16539	Central Plateaus	5521	480005.01	5398832.85	MRT and DPIPWE

Appendix G: Recreational Waters

Precautionary approach for recreational waters microorganisms

For recreational waters microorganisms are used as a regulatory parameter of public health significance. The indicator organism used for microbiological water quality assessment is intestinal enterococci and is related to a risk matrix which uses sanitary inspection of potential faecal contamination sources and 95th percentile levels of enterococci/100mL.

The Recreational Water Quality Guidelines (Tasmania 2007), under the *Public Health Act 1997*, for a general water body (where no sanitary risk assessment has been undertaken) has determined microbial levels for investigation and action to informing the public of the elevated public health risk. These levels are at enterococci counts in a single water sample greater than 140 enterococci/100mL and when two consecutive water samples results are greater than 280 enterococci/100mL.

A precautionary approach is however recommended, where microbial levels should be at 40 enterococci/100mL or less for recreational waters where waters may be affected by sewage treatment plant discharges or malfunctioning sewerage systems (e.g., pump station overflows), and this trigger should be the DGV for this key faecal bacteria indicator. Refer to the Australian Government Guidelines for Managing Risk in Recreational Water for more detail on the sanitary risk classification matrix for faecal pollution of recreational water and other key indicators DGVs.

ENVIRONMENT PROTECTION AUTHORITY