WATER

WATER QUALITY TARGETS: A HANDBOOK

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1. Introduction

The importance of water quality

Australia is currently facing critical salinity and water quality problems, which are expected to become more severe over the coming decades. Our precious water resources are under increasing pressure from water shortages, drought, pollution and over-extraction, all of which necessitates that we change the way we manage and use water.

Poor water quality affects us all, directly and indirectly.
Imagine if you could not:

- eat the fish you had caught out of our estuaries, lakes or oceans because they were contaminated by pollutants;
- swim at your local beach or swimming hole due to sewage contamination or outbreaks of algal blooms; or
- irrigate your crops because the water was too saline.

In some areas of Australia we face these problems right now. The solutions are not easy and it will take some time to improve the condition of our waterways – time we cannot afford to waste.

How do we manage water quality?

Managing water quality requires a catchment-based approach to management planning, with staged actions required to reach long-term goals. Effective natural resource management also requires recognition of the influence catchments and land uses have on the quality of water resources.

The causes of many water quality problems are broad-scale in origin and hence may need regional solutions with actions applied at the local level to be effective. A concerted effort by land managers, industry, catchment groups, the community, environmental groups and Commonwealth, State and local governments will be required in order to protect our water resources for future generations.

Water quality targets

In October 2000, the Prime Minister announced the *National Action Plan for Salinity and Water Quality (NAP)*, involving a Commonwealth funding commitment of $700 million over seven years, to address salinity and water quality issues in 21 priority catchments. Implementation of the *NAP* is administered through agreements between State/Territory governments and the Commonwealth. Funding under the *NAP* is in addition to that provided under the extension of the *Natural Heritage Trust (NHT)*.

Under the *NAP* and *NHT*, funding assistance for regions will be based on regional NRM plans which will specify targets for the maintenance and improvement of the natural resources within these catchments, particularly in relation to salinity, water quality and biodiversity. These targets will be based on agreed national standards.

Regional NRM plans will need to be sufficiently comprehensive to provide a sound basis for the Commonwealth and State Governments to invest in them, and for the regions to commit to implementing the priority actions the plan describes. Regional NRM plans will be jointly accredited by the Commonwealth and States to ensure they meet nationally agreed accreditation criteria.

When setting water quality targets, the community and other stakeholders should define what they want to protect. They need to identify the uses of the water resources required now and for the future and those requiring protection from the effects of pollution or degrading activities (e.g. ecosystem protection, drinking water and recreation). These uses are known as 'environmental values'.

Once these environmental values have been decided, targets should be set to achieve or maintain them. Water quality targets are influenced by environmental, social and economic considerations, which in most cases will be unique to that region. Targets should also, where possible, have regard for current condition, and long-term trends in water quality. For example, salinity may continue to increase for some time yet, irrespective of management actions.

Indicator: a parameter used to provide a measure of the quality of water or condition of an ecosystem.

Environmental Values: the values or uses of the water that we wish to protect.

Water Quality Targets: numerical levels or descriptive statements that must be met within a specified timeframe to protect and maintain environmental values.

Purpose

This handbook aims to assist regional groups to set environmental values and water quality targets for their catchments/region. These targets will be used in developing regional plans to guide investments, management and progress towards attainment of regional goals.

Setting water quality targets can be a complex process. This handbook outlines the steps to be followed to set default targets derived from the published guidelines in *The Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000), hereafter called the *Water Quality Guidelines.* The *Water Quality Guidelines* provides comprehensive information and procedures for setting more specific water quality targets tailored for unique conditions for a range of pollutants or indicators and may be used to further customise water quality targets for local conditions.

When used in conjunction with *Water Quality Targets OnLine* (www.ea.gov.au/water/quality/targets), this handbook simplifies the task of setting water quality targets when preparing regional plans. It is not prescriptive and is intended as a tool to assist the planning process. It is anticipated that some regions or catchments may already be involved in developing regional plans and have set environmental values and water quality targets.

2. Background

What are environmental values?

Environmental values describe what we want and need to protect. They outline values and beneficial uses of the environment that are important for healthy ecosystems, public benefit, industry and health that require protection from the effects of pollution and waste discharges. For any water body, the following environmental values may require protection:

- Aquatic ecosystems;
- Primary industries (irrigation and general water uses, stock drinking water, aquaculture and human consumption of aquatic foods);
- Recreation and aesthetics;
- Drinking water;
- Industrial water; and
- Cultural and spiritual values.

No specific water quality guidelines are provided for industrial water and cultural and spiritual values. These values cover a range of specific uses and should be considered by the community in the planning and management of their water resources.

Environmental values are the expression of the community's desires and needs for a water body (or portion of a water body). Environmental values are those a community wishes to protect and enjoy now and in the future, and should be set in consultation with the broader community. The values should:

- have support from the local community, interest groups and the wider region;
- be consistent with the area's needs;
- consider the needs of downstream communities; and
- consider the values of downstream receiving water bodies.

The setting of an environmental value may:

- aim to improve the current water quality conditions;
- achieve a different water quality in each of a number of specified segments of a water body;

- recognise a section of a waterway cannot achieve a certain water quality at a particular time; or
- maintain or protect the current condition of a water body and ensure no degradation of the current water quality occurs.

What are targets?

Targets measure or guide progress towards an overall resource management goal or outcome. They should:

- define an acceptable, physical condition of catchment health;
- relate to the current ecological and water quality condition of the water body;
- be measurable and time-specific;
- relate to any existing targets established under statutory planning or environmental protection processes and policies;
- provide a focus for actions and investment; and
- be based on trend information, scientific studies or best available information, where possible.

Water quality targets

Water quality targets should focus on water quality issues (e.g. algal blooms) that impair or threaten the environmental values of a water body. The National Framework for Natural Resource Management (NRM) Standards and Targets outlines the minimum set of matters for which regional targets are required. Under this framework targets are required for water quality issues including salinity, nutrients and sediment/suspended solids. Water quality targets may be set for other matters in addition to the minimum set depending on the water quality issues in the catchment.

Targets should be set for each key management issue and may include a range of scales and time frames, as some issues take longer to address than others. Targets can be:

- visions or goals for the region: long-term targets that cannot be reached immediately but are needed to protect the environmental values of the water body. They may be numerical, descriptive or relative (e.g. no net loss) statements;

- resource condition targets: specific, measurable and time-bound targets used to work towards the overall goal or vision for the water body. They may be medium term targets (10-20 years) required for regional planning (e.g. 30 per cent reduction in phosphorus loads by 2006); or
- management action targets: targets that are linked closely to management actions. They are usually measurable and time-bound but with shorter time spans (1-5 years) than the regional targets, (e.g. 70 km of riparian vegetation is to be fenced within five years).

Water quality targets can be set for physical, chemical and biological components of aquatic ecosystems. Once defined, water quality targets become indicators of management performance and progress towards management goals or attainment of environmental values.

Local water quality targets should be established through partnership between community and government. The process should involve:

- a consistent and documented approach to setting targets;
- a wide range of stakeholders; and
- a clear and flexible plan, with responsibilities assigned to each action and monitoring and reporting on progress.

As information comes to hand, targets may be refined to ensure continued progress towards the overall goals. The processes for monitoring and evaluation must be developed in conjunction with the target setting process to measure progress and identify changes to resource condition or management.

3. Consultative Processes

Obtaining input from community and relevant individuals and organisations is an important first step when identifying environmental values and setting water quality targets for the region. Some catchments or regions may already have consultative processes in place and these groups may be able to or have started to move straight to the steps for setting environmental values and/or water quality targets. It is important to be familiar with any planning processes already underway or completed within the region.

As part of this initial process, State/Territory agencies will play a vital role in determining environmental values and setting targets for water bodies. These agencies for example, will need to indicate any limits to environmental values and targets due to statutory obligations or regulations. For example, in a World Heritage area, environmental values will need to include *aquatic ecosystem protection*.

Step 1: Set up the catchment management or other planning group

Identify stakeholders

The first step is to identify all the stakeholders. Stakeholders are people and organisations that have an interest in, are affected by or are involved in a water quality issue. Stakeholders may have different ideas about the values requiring protection and consultation processes should try to get input from as many stakeholders as possible.

Stakeholders may include:

- Research bodies;
- Land owners;
- Industry representatives;
- Community members and interest groups;
- Educational institutions, such as schools and universities;
- Local, State/Territory, Commonwealth Government departments and agencies;
- Environmental groups;

- Primary industry, such as Landcare groups, farmers' organisations, irrigation corporations, fishing organisations;
- Water industry and managers;
- Inter-governmental bodies, such as the Murray-Darling Basin Commission;
- Tourism industry; and
- Coordination groups, such as catchment management committees and trusts.

Role and Group Membership

A regional planning group should be established. The group usually covers a particular geographical area, catchment, aquifer, bay or estuary and is representative of all key stakeholders. Under the *NAP* and *NHT*, regional planning groups have or will be established for this purpose. Suggested selection criteria for community and local government representatives are:

- the ability to contribute directly to managing the process;
- the ability and eagerness to contribute;
- the ability to represent a wide variety of community views;
- familiarity with water quality management issues; and
- commonsense and ability to work with people.

The group is responsible for overseeing and coordinating identification of environmental values and setting water quality targets. Groups should aim to:

- encourage everyone who is interested to participate;
- hear and consider a wide range of views;
- develop an open process from the beginning;
- raise awareness of water quality and management issues in the local community;
- include a broad range of stakeholders;
- ensure good communication and liaison with key stakeholders;
- allow representation according to local needs; and
- resist domination by sectoral interests.

The regional planning group will help local communities understand the process of identifying environmental values and setting water quality targets.

Step 2: Develop appropriate mechanisms for stakeholder involvement

To ensure everyone can be involved, mechanisms for stakeholder involvement should be developed. These may vary between regions or catchments but should include raising awareness and developing mechanisms for stakeholder involvement and feedback.

Raise awareness of the issues

To maximise input from the consultation process, all stakeholders should understand what they are being asked to do, why it is important, how the process is going to work and how they will provide input to the process. The group should provide information to stakeholders that answers common questions such as:

- What are environmental values and water quality targets?
- Why do we need to determine environmental values and water quality targets?
- How do we determine them?
- What sorts of things might be affecting environmental values and water quality targets?

Information sessions, meetings, brochures, advertisements and displays can be used to raise awareness of the issues and provide information about the consultative process. Next, input can be sought from the community and other stakeholders on determining environmental values and water quality targets for the area.

Consultative processes

The stakeholders can be involved through meetings, discussion forums, field trips and surveys. Discussion forums can be held, outlining the purpose and background of the consultations followed by group or open floor discussions led by facilitators and including technical input. The views and discussions raised should be recorded. It may be useful to establish a stakeholder advisory committee to bring together all major interests in one forum to discuss ideas, issues and proposals and provide a sounding board.

Where there are a large number of interest groups, mechanisms should be established to canvass all views and provide feedback as the process evolves. The lead group should ensure:

- meetings are widely advertised, registration is easy and there is a system in place for delivering background information and agendas to all participants prior to meetings;
- conflict resolution measures such as facilitators are available as required;
- outcomes such as draft environmental values and water quality targets are accessible to all stakeholders;
- mechanisms are in place for obtaining comment on drafts and plans;
- recommendations are put forward from the consultation process (these may include scientific and economic assessments); and
- contact is made and maintained with all stakeholders, including those with strongly opposing views.

4. Identifying Environmental Values

Before identifying environmental values, the boundaries and scale of the task need to be set. The steps shown here outline the preferred process (Figure 1), however, this may differ slightly between states, territories, regions or catchments.

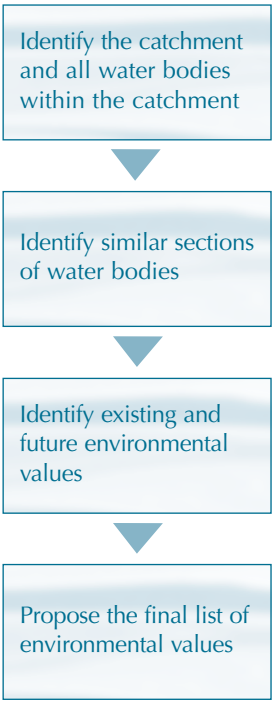

Figure 1. Major steps involved in identifying environmental values of water.

Step 1: Identify the catchment and all relevant water bodies

A catchment is the area of land drained by a river or lake and its tributaries (including groundwater). Environmental values will need to be set for streams, rivers, lakes, wetlands, estuaries and coastal or marine water bodies within the catchment. Large catchments may be more manageable if they are broken into sub-catchments. In some cases, catchment boundaries may need modification to take account of major aquifers crossing catchment boundaries.

The group will need to identify the catchment or sub-catchments in question. Topographic maps can be used to assist in identifying catchment and sub-catchment boundaries. State and local government boundaries should also be taken into consideration.

Ideally, environmental values should be set for each water body, flowing or static, in the catchment. However, logistically it may be difficult to designate environmental values and water quality targets for every stream, tributary, bay or aquifer within the region on an individual basis and the group may wish to consider grouping like water bodies to simplify this task.

Step 2: Divide water bodies into similar sections for identification of environmental values.

Catchments consist of a number of linked water bodies such as streams, rivers, lakes, wetlands and estuaries. Targets set upstream may influence the values and targets set downstream and vice-versa.

To set values for water bodies within a catchment, each water body should be divided into distinct sections or segments. For example, an estuary may need to be divided for the purposes of establishing water quality targets because some sections may support fishing or swimming or are associated with a wildlife conservation reserve.

Topographic maps, catchment management maps and others such as street directories will help define major boundaries in the water bodies throughout the catchment.

Sections of water bodies may be identified based upon:

- major changes in the stream network (where tributaries join the main river channel);
- planning unit and other administrative boundaries;
- natural and artificial barriers (major dams, weirs and natural barriers such as waterfalls, rapids, wetlands);
- major changes in land use (national parks, state parks, conservation areas, reserves, forests, plantations, boundaries of natural vegetation types);
- a distinct change in water use, indicative of a change of environmental value (for example, a groundwater mound used for drinking water supply);
- tidal limit and boundaries between intermittent and permanent streams; and
- discharge points and major disturbance sites (sewerage and industrial discharge points, sand and gravel extraction, dairies, piggeries and cattle feedlots).

Step 3: Identify the existing and future environmental values for each water body.

The next step is to designate environmental values for each section. The community and other stakeholders should begin by identifying the environmental values they want to protect now and in the future. This process will explicitly involve broad community consultation and consideration of ecological, social and economic factors and the aspirations and expectations of the local community.

Environmental values should be determined for all waters and these sections, with a particular water body often holding more than one value. For each section of water, the regional planning group should list:

1 the types of water uses and activities (such as drinking water, agricultural, industrial, ecosystem protection and recreation);

2 the number and location of these uses and activities;

3 any default values, uses or activities (water bodies in a World Heritage area or marine park will have the environmental value of *aquatic ecosystem protection* as a minimum and may also have others);

4 the duration of these uses (*recreation* may apply only at certain times of the year);

5 proposed future uses or activities; and

6 any other environmental, social and economic considerations that may influence the selected environmental values.

Many water bodies will have default environmental values that should not be compromised (Appendix 1). For example, water bodies encompassed by National Parks, conservation reserves, World Heritage areas or classified as Ramsar wetlands will have the default environmental value of *aquatic ecosystem protection* and in many cases will have others such as *recreation and aesthetics*. Similarly, the environmental value of *drinking water* should not be compromised for water bodies (including groundwater aquifers) that are designated for this purpose. In these water bodies, the default environmental value will not exclude the assignment of other environmental values (e.g. *primary industries* - production of aquatic foods for human consumption) but the default value will generally take precedence.

Additionally, any environmental values that are provided for or outlined in state environmental protection policies, or other statutory processes should be recognised and provided for.

Sources of information

Groups can obtain information about current uses and values from local knowledge, surveys, monitoring programs, maps, scientific reports, books, environmental protection policies and planning documents. Stakeholder knowledge of recreation patterns and perceptions of the relative naturalness of different sections of waterway can help identify the environmental values of sections of water bodies. Maps can provide information on the location of reservoirs, weirs, swimming holes, walking trails, boat ramps, water supply catchments and protected areas such as national parks and reserves. Surveys of residential, business and tourism communities will provide information on uses and values of importance to the broader community.

All of the uses proposed as environmental values by the community and other stakeholders should be listed and evaluated to make sure they are uses that require protection from the effects of pollution. Specific uses can then be aligned with the broad environmental values (Table 1).

Information for setting Environmental Values:

- Maps
- Surveys
- Local knowledge
- Discussions
- Reports
- Planning documents
- Scientific information
- Monitoring data

Table 1. Environmental values and some attendant uses. The existing uses of water often provide a strong indication as to the environmental values to be protected.

Environmental values of water	Examples of use
Aquatic ecosystems	Maintenance of aquatic ecosystems Fish breeding and spawning Biodiversity conservation Eco-tourism
Primary industry	Irrigated agriculture Aquaculture Human consumption of aquatic foods Stock drinking water Commercial fishing
Recreation and aesthetics (primary and secondary contact)	Swimming Recreational fishing Boating Visual amenity
Drinking water	Human consumption (from tap)
Industrial Water	Washing Cooling Processing requirements
Cultural and spiritual	Sacred sites Spiritual use Presence of certain plant and animal communities Traditional use

In determining environmental values for each water body, the values set for neighbouring and downstream sections of water bodies should be considered because they may impact on the water quality of the water body of concern.

The regional planning group and stakeholders should be aware the water quality they desire for a water body may not be immediately achievable and in some cases may never be reached. Water quality monitoring (physical, chemical and biological) data can be used to determine the environmental values currently supported by a water body. Monitoring can indicate how much change is acceptable to maintain those values or is needed to support new or additional values. The **Try A Target** function in *Water Quality Targets OnLine* enables users to enter a concentration/value for an indicator and then displays the environmental values supported by that value.

Once the group has made a draft list of environmental values for each section of waterway, they may set aside time for public consultation and comment. This will ensure all stakeholders have a chance to comment before the list is finalised.

Level of protection

Where *aquatic ecosystem protection* is determined to be an environmental value, a decision is required as to what level of protection is needed. This will, in turn, directly influence the water quality targets and management actions to be set for that water body. There are three levels of protection:

- *High conservation/ecological value systems*. These are systems that are largely unmodified or have undergone little change from natural. They are often found within national parks, conservation reserves or inaccessible locations. Targets for these systems aim to maintain no discernable change from this natural condition (no physical, chemical and biological change).
- *Slightly to moderately disturbed systems*. These systems have undergone some changes but are not considered so degraded as to be highly disturbed. Aquatic biological diversity may have been affected to some degree but the natural communities are still largely intact and functioning. An increased level of change in physical, chemical and biological aspects of these ecosystems is to be expected.
- *Highly disturbed systems*. These are degraded systems likely to have lower levels of naturalness. These systems may still retain some ecological or conservation values that require protecting. Targets for these systems are likely to be less stringent and may be aimed at retaining a functional but highly modified ecosystem that supports other environmental values also assigned to it (e.g. fishing).

The regional planning group should decide the appropriate level of protection based on the community's long-term desires for the ecosystem and other environmental, social and economic considerations. They should choose whether to maintain the existing condition or improve a modified ecosystem by targeting the most appropriate condition level. More information on the level of protection can be found in the *Water Quality Guidelines*.

5. Setting Water Quality Targets

Water quality targets may be set for physical, chemical and biological aspects of aquatic ecosystems. Setting water quality targets involves dealing with each water body section in turn and defining the water quality conditions required to maintain or protect the environmental value with the most stringent water quality requirements (Figure 2).

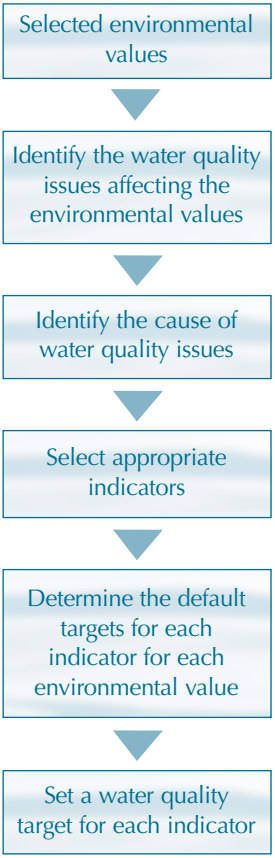

Figure 2. Major steps in setting water quality targets.

Step 1: Identify the water quality issues preventing achievement of environmental values for each section.

When the environmental values have been defined, the regional planning group should determine where these values are not being met and why. The group should find out which processes, activities, issues or land uses impact on the proposed values. For example, algal blooms may be preventing recreation and threatening the use of water for stock. Table 2 outlines some common water quality issues and associated pollutants.

The list of issues and concerns should include a description of their impact on the environmental values assigned to the water body. Environmental flows may also influence certain water quality issues (such as algal blooms and sedimentation) and should be considered when determining the causes of the water quality issues. Monitoring data, studies and reports, best professional judgement, community input and observation can be used to identify water quality issues.

Table 2. Common water quality issues affecting the environmental values of water and associated pollutants.

Environmental value	Common water quality issues	Common pollutants
Aquatic ecosystems	Stress/death of fish	Low dissolved oxygen, toxicity (algal blooms or chemical contamination), pH, salinity, habitat modification, flow alteration and temperature
	Loss of diversity of aquatic animals	Chemical contamination, altered habitat conditions (sediment, algal blooms), acidic waters, increased salinity, heavy metal contamination, dissolved oxygen levels, flow alteration and temperature
	Loss of seagrasses	Nutrients and turbidity
	Smothering of aquatic fauna	Suspended sediment
	Loss of spawning trigger for fish	Flow alteration and temperature
	Loss of aquatic plants	Acidic waters
Drinking water	Taste and odour problems from algal blooms and suspended sediment	Nutrients, sediment and salinity
	Human health problems and scares	Toxins from algal blooms, chemical contamination, viruses, faecal coliforms and other micro-organisms
	Reduced treatment and disinfection capability	Nutrients and suspended sediment
Primary industries (irrigation, stock, aquaculture, human consumption of aquatic foods)	Water unsuitable for consumption by stock	Toxins, suspended sediment and salinity
	Contaminated foods (such as mussels, oysters)	Heavy metals, chemical contamination, viruses, faecal coliforms and other micro-organisms
	Fouled pumps and corroded pipes	Suspended sediment, pH, and salinity
	Water unsuitable for irrigation	Salinity
Recreation and aesthetics	Smell and odour problems Beach closures (health risks)	Nutrients and sediment Viruses, faecal coliforms and other micro-organisms
	Nuisance growth of aquatic plants scums, toxic blue greens	Nutrients, turbidity, light and temperature
Industrial	Blockage of intake screens from algal or plant growth	Nutrients and light
	Equipment fouling, corroding pipes	Suspended sediment, pH and salinity
Cultural and spiritual	Dependent on the particular cultural and spiritual use/value	Dependent on the particular cultural and spiritual use/value

Step 2: Identify the set of pollutants or other water quality attributes causing the water quality issues.

Once the key issues preventing achievement of environmental values are identified, the key pollutants and other factors causing these problems should be determined (Table 2). For example, algal blooms are often caused by increases in nutrients. In some cases, scientific investigations and monitoring programs may be required to determine the precise cause of a water quality issue. However, the likely pollutants can usually be determined using existing scientific knowledge, best professional judgement, reports, surveys and monitoring programs. Examples of the sources of common types of pollutants have been outlined in Appendix 3.

Step 3: Select indicators for each water quality issue and environmental value.

An indicator is a parameter that can be used to provide a measure of the quality of water or ecosystem condition. Relevant indicators can be determined from the water quality issues and their associated pollutants.

Physical, chemical and biological aspects of water and sediment are often used as indicators of the health of an ecosystem.

Physical and chemical indicators include nutrients, dissolved oxygen, biodegradable organic matter, suspended particulate matter, turbidity, temperature, salinity, pH and changes in flow regime. Toxicants are chemical contaminants such as metals, aromatic hydrocarbons, pesticides and herbicides that can have toxic effects at certain concentrations.

Biological indicators provide information on changes in water quality or physical habitat. They include insects, fish, algae, plants and other organisms. Biological indicators may provide a more direct measure of ecosystem health than episodic sampling of physical and chemical measures.

A minimum set of water quality indicators is being defined, for measurement under the *NAP* and *NHT*. These indicators will address the minimum set of matters for which targets are required. For water quality, indicators will be required to address nutrients (nitrogen and phosphorus), salinity, sediment or suspended solids and river health. Finalisation of these indicators may lead to the derivation of more specific indicators for different ecosystems.

Many biological and ecological processes vary between different types of ecosystems. This may influence the indicators selected for different ecosystems (Table 3). For example, in riverine systems, total phosphorus is often used as a primary water quality indicator because it represents the maximum amount of phosphorus that may ultimately become biologically available and contribute to nutrient enrichment and algal blooms. In contrast, filterable reactive phosphate may be a more appropriate indicator in wetlands and estuarine ecosystems because it is a better measure of the availability of soluble forms of phosphorus, which may limit primary production and eutrophication in these systems.

The selection of indicators in addition to the minimum set is encouraged, as this may assist interpretation, provide valuable information on the condition of an environmental value, or help set additional targets necessary to attain or protect an environmental value. Local information constraints, resource constraints and availability of expertise may restrict the choice of additional indicators.

Table 3. Examples of water quality indicators for different ecosystem types.

Indicator	Rivers	Groundwater	Lakes	Wetlands	Estuaries	Marine
Total Nitrogen	✓					
Nitrate		✓				
Dissolved Inorganic Nitrogen			✓	✓	✓	✓
Total Phosphorus	✓					
Filterable reactive phosphate			✓	✓	✓	✓
Turbidity/suspended sediment	✓					
Transparency			✓	✓	✓	✓
Salinity	✓	✓	✓	✓		

In some cases, there may be no value available on *Water Quality Targets OnLine* for a certain indicator for a particular environmental value. Where appropriate, the use of a related indicator is recommended (e.g. nitrate instead of total nitrogen or filterable reactive phosphate instead of total phosphorus). Related forms are often used as indicators because they are considered more relevant to the water quality problem at hand, or are more likely to affect particular uses or values than the parent form in many instances.

In a few instances, values for the required and related indicators may be unavailable on *Water Quality Targets OnLine*. In these cases the indicator may not be relevant to the selected ecosystem type or environmental value.

Numerical targets for biological indicators have not been provided in *Water Quality Targets OnLine*. Information and techniques for using biological indicators can be found in the *Water Quality Guidelines*.

Step 4: Determine the default targets for each indicator for each environmental value in each section

Once all of the indicators have been selected the group will need to determine the numerical targets for each indicator that will protect the selected environmental values. There are a number of techniques for deriving water quality targets for example, using the published guidelines, reference data or biological data. The method to be used is ultimately a matter for the group and will be influenced by the availability of data and resources. For the purposes of this Handbook, targets are to be derived using the default targets in *Water Quality Targets OnLine*. Procedures for using reference or biological data to derive targets or for tailoring targets for local conditions are described in the *Water Quality Guidelines*.

Water Quality Targets OnLine can assist in quickly and easily determining the default water quality targets for each indicator and is available at www.ea.gov.au/water/quality/targets or on the CD at the back of this handbook. The water quality targets associated with some environmental values vary depending upon the region or type of ecosystem in question. The group will need to select their:

- region of Australia (south east Australia, tropical Australia, south west Australia, south central Australia);
- type of ecosystem (upland river, lowland river, lake, wetland, estuary);
- environmental value to be protected; and
- relevant indicators.

Step 5: Set water quality targets

Once the group has a default target for each indicator, for each environmental value, they will need to determine which default target is the most stringent. The most stringent default target will in many cases also protect the other environmental values. In most cases, the water quality requirements for protection of *aquatic ecosystems* are the most stringent of all the environmental values. However, the order or stringency may vary between different indicators.

There are no explicit guidelines to protect *industrial* or *cultural and spiritual* values, so the water quality requirements for these environmental values should be considered relative to the specific use.

The most stringent default target for each indicator can be determined by using the **Show All** function in *Water Quality Targets OnLine*. The selected target for each indicator forms the basis for setting water quality targets for each identified water body.

Each target needs to be set within a timeframe for attainment and then applied to the selected water bodies or portions of water bodies. A map could be used to show the water bodies or portions of water bodies and their selected environmental values and targets.

Water quality targets should be derived for all identified water bodies and for all required water quality indicators. Water quality targets should be expressed as time-bound milestones for water quality improvement (e.g. <3.0 mg/l nitrate by 2008). In many situations, the targets may take considerable time to achieve and interim targets can be set. Interim targets are shorter-term and may be closely linked to management actions. Interim targets may be useful where long-term goals are uncertain or additional scientific information is required. They allow management actions and targets to be refined and continually improved based upon future monitoring (adaptive management).

Once set, targets may be refined as more information becomes available. Trade-offs between environmental, economic and social objectives may further modify the water quality targets. These trade-offs should be documented.

Environmental values and water quality targets set for sections further upstream may affect downstream sections of the same river or stream. Where targets are being set for a number of water bodies, the interactions between sections of waterway within the catchment should be considered.

No specific guidance for setting biological targets is provided in this handbook, but future versions may address target setting for biological indicators as the measures are further developed. Information on using biological indicators for assessing water quality can be found in the *Water Quality Guidelines.*

6. Glossary

Term	Definition
Acidic	Having a pH less than 7 (a high hydrogen ion concentration)
Aesthetic	Aspects of, say, a water body, considered beautiful or pleasant to the senses
Algae	Comparatively simple chlorophyll-bearing plants, mostly aquatic and microscopic in size
Aquaculture	Commonly called fish farming, but broadly refers to the commercial growing of marine or freshwater animals and aquatic plants
Aquatic ecosystem	Any watery environment - small to large, pond to ocean - where plants and animals interact with the chemical and physical features of the environment
Aquifer	An underground layer of permeable rock, sand or gravel that absorbs water and allows it to pass freely through pore spaces
Biota	The sum total of the living organisms of any designated area
Bloom	An unusually large number of organisms per unit of water, usually algae, made up of one or a few species
Catchment	The area of land from which a river, lake or estuary gathers its water, including all tributaries and groundwater flowing into the main river, lake or estuary
Concentration	The quantifiable amount of chemical in, say, water, food or sediment
Contaminant	Biological (e.g. bacterial and viral pathogens) and chemical (see Toxicants) introductions capable of producing an adverse effect in a biological system, seriously injuring structure or function or causing death

Ecosystem condition	Current or desired status of health of an ecosystem, as affected by human disturbance
Electrical conductivity	The ability of water or soil solution to conduct an electric current (EC)
Environmental values	Particular values or uses of the environment important for a healthy ecosystem or for public benefit, welfare, safety or health and requiring protection from the effects of pollution or degradation. Several environmental values may be designated for a specific water body.
Groundwater	Water stored underground in rock crevices and in the pores of geologic materials making up the earth's crust; water that supplies springs and wells
Habitat	The place where a population (e.g. human, animal, plant, micro-organism) lives and its surroundings, both living and non-living
Indicator	A parameter used to provide a measure of the quality of water or the condition of an ecosystem. They can be biological indicators (e.g. species composition, species abundance), or physical or chemical indicators (e.g. dissolved oxygen concentration, temperature, flow duration).
Level of protection	A level of quality desired by stakeholders and implied by the selected management goals for the water resource
Management goals	Long-term management objectives used to assess whether the corresponding environmental value is being maintained. They should reflect the desired levels of protection for the aquatic system and any relevant environmental problems.
Pesticide	A substance or mixture of substances used to kill unwanted species of plants or animals

pH	Value representing the acidity or alkalinity of an aqueous solution. It is defined as the negative logarithm of the hydrogen ion concentration of the solution.
Pollution	The introduction of unwanted components into water, air or soil, usually as a result of human activity, such as hot water in rivers, sewage in the sea, oil on land
Salinity	The presence of soluble salts in or on soils or in water
Sediment	Unconsolidated mineral and organic particulate material that settles to the bottom of aquatic environment
Stakeholder	A person or group (e.g. an industry, government jurisdiction, community group, the public) with an interest or concern in something
Toxicant	A chemical capable of producing an adverse effect in a biological system at concentrations encountered in the environment, seriously injuring structure or function or causing death. Examples include pesticides, heavy metals and biotoxins.
Water quality target	Water quality targets are numerical levels or descriptive statements, that when met within a specified timeframe will protect and maintain environmental values. They are based on scientific guidelines, but may be modified by social, political, economic or cultural constraints

7. Further Information

ANZECC and ARMCANZ (2000). *The Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra. (www.ea.gov.au/water/quality/nwqms/index.html)

ANZECC & ARMCANZ (2000)b. *Australian Guidelines for Water Quality Monitoring and Reportin*g. National Water Quality Management Strategy Paper No 7, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra. (www.ea.gov.au/water/quality/nwqms/index.html)

Bennett, J., Sanders, N., Moulton, D., Phillips, N., Lukacs, G., Walker, K., and Redfern, F. (2002). *Guidelines for Protecting Australian Waterways*. Land & Water Australia, Canberra.

Liston, P. and Maher, W. (1997). *Water Quality for Maintenance of Aquatic Ecosystems: Appropriate Indicators and Analysis*, Australia: State of the Environment Technical Paper Series (Inland Waters), Department of the Environment, Sport and Territories, Canberra.

Murray-Darling Basin Ministerial Council (2001). *Integrated Catchment Management in the Murray-Darling Basin 2001-2010. Delivering a sustainable future*. Murray-Darling Basin Ministerial Council, Canberra.

Useful web links

The Australian River Assessment System (AusRivAS; http://ausrivas.canberra.edu.au/)

Links to Commonwealth, State and Territory Environmental Legislation (http://www.ea.gov.au/sdd/library/infoterra/regulation.html)

National Action Plan for Salinity and Water Quality (http://www.napswq.gov.au)

Natural Heritage Trust (http://www.nht.gov.au/)

National River Health Program (http://www.ea.gov.au/water/programs/index.html)

Waterwatch Australia (http://www.waterwatch.org.au/)

Water Quality Targets OnLine (http://www.ea.gov.au/water/quality/targets)

Appendix 1: Default environmental values

Table 4 Examples of land uses or conventions that may attract default environmental values

Environmental value	Designated land use/convention
Aquatic ecosystems	World Heritage Areas Ramsar Wetlands National Parks Treaty/convention Conservation Reserves Areas of National Environmental Significance Sanctuaries (e.g. Whale) Threatened or protected species
Primary industry	Gazetted fishing zone
Recreation and aesthetics (primary and secondary contact)	Designated recreation areas (swimming holes, beaches, pools etc) Designated scenic lookouts and trails
Drinking water	Designated drinking water source (aquifer or surface)

Appendix 2: Case Study

The community and other stakeholders have agreed that they want to use a particular reach of a lowland freshwater river for swimming and irrigation of their orange orchards. They also want to maintain the aquatic ecosystem of the reach. They assign the environmental values of *aquatic ecosystem protection* (at the slightly to moderately disturbed level), *recreation* (primary contact) and *primary industries* (irrigation) to this reach.

The group wants to set water quality targets to protect these environmental values. They use *Water Quality Targets OnLine* to look up the values of each indicator required to protect each of these environmental values (Table 5).

Table 5. Water quality required for the selected indicators to protect or maintain the environmental values of *primary industries*, *aquatic ecosystem protection* and *recreation*. Bold text represents the most stringent default target.

Indicator	Primary industries (irrigation) - oranges	Aquatic Ecosystem Protection (slightly–moderately disturbed)	Recreation (primary contact)
TN	5 000 micro g/L LTT 25 000-125 000 micro g/L STT	**1 000 micro g /L**	—
TP	**50 micro g/L LTT** 800-1 200 micro g/L STT	100 micro g /L	—
Turbidity/ Suspended sediment	—	**1-50 NTU** – Highly variable, depends on seasonal rainfall run-off	No turbidity level specified. Secchi disc (200mm) diameter sighted horizontally >1.6m
Surface water salinity (EC) micro S/cm	1 700 in loam **1 000 in clay** 2 900 in sand (Plant tolerances to irrigation water)	100-5 000 micro S/cm - Can be highly variable, depends on flow	No EC level specified

— No value is available for this indicator for this environmental value

STT (short-term targets) is the maximum concentration (micro g/L) of contaminant in the irrigation water that can be tolerated for a short period of time (up to 20 years). LTT (long-term targets) maximum concentration (micro g/L) of contaminant in the irrigation water that can be tolerated for long period of time (up to 100 years).

Monitoring has been undertaken and the current water quality for each of the selected indicators is as follows:

10 000 micro g/L of total nitrogen;
100 micro g/L of total phosphorus;
30 NTU for turbidity; and
2 500 micro S/cm of EC for surface water salinity.

To ensure all environmental values will be maintained, the group decide to use the most stringent default target for each indicator as the water quality targets for their water body. For salinity, the group decides to use the default salinity target for irrigating oranges on loam soils, the area's dominant soil type. This level is still within the natural variation in salinity levels for maintenance of aquatic ecosystems.

They set timeframes for attainment of each target as follows:

- achieve total nitrogen levels of 1 000 micro g/L by 2015;
- achieve total phosphorus levels of 50 micro g/L by 2010;
- maintain turbidity levels of 30 NTU; and
- achieve surface water salinity levels 1 700 micro S/cm EC by 2015.

Table 6. Examples of water quality pollutants and their common sources.

	Point sources				Non point sources							Other	
	Industry	Wastewater treatment plant	Animal feedlots	Mines	Stormwater	Agriculture	Forestry	Construction	Septic	Landfills	Atmosphere	Shipping/ Marinas	Dredging
Pathogens viruses, bacteria, protozoa		✓	✓	✓	✓	✓			✓	✓		✓	
Toxicants (chemicals, metals, pesticides, herbicides)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sediment	✓		✓	✓	✓	✓	✓	✓		✓			✓
Nutrients	✓	✓	✓		✓	✓	✓		✓		✓	✓	✓
Salinity	✓					✓	✓						
Temperature	✓			✓			✓						
Debris	✓	✓			✓			✓				✓	✓