

- PHASE ONE REPORT - TOWARDS THE DEVELOPMENT OF A WATER QUALITY PROTECTION PLAN FOR THE DARWIN HARBOUR REGION



*A biologically rich and diverse marine and terrestrial environment
for our use and enjoyment today, and for our children tomorrow...*

**Aquatic Health Unit
April 2009**

J. Fortune & G. Maly 2009



**Department of Natural Resources, Environment, the Arts and Sport.
Environment, Heritage and the Arts.
Aquatic Health Unit.**

This report describes activities undertaken in the development towards a Water Quality Protection Plan for the Darwin Harbour Region. The process was undertaken in consultation with the Ecosystem Monitoring Group, a technical advisory body of the Darwin Harbour Advisory Committee and a number of other key stakeholders. Broader public consultation was also undertaken to determine beneficial uses for the Darwin Region which is further described within this report.

The Department of Natural Resources, Environment the Arts and Sport kindly acknowledges the support of the Australian Government in the development of a Water Quality Protection Plan for the Darwin Region.

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Northern Territory Government



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General Disclaimer: The information contained in this report comprises general statements based on scientific research and monitoring. The reader is advised that some information may be incomplete or unable to be applied in areas outside the Darwin Harbour region. Some information may be superseded by future scientific studies, new technology and/or industry practices.

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Acronyms

DAC	Darwin Aquaculture Centre
DCC	Darwin City Council
DHRWQM	Darwin Harbour Receiving Water Quality Model
DHAC	Darwin Harbour Advisory Committee
DPI	Department of Planning and Infrastructure Department of Regional Development, Primary Industry, Fisheries and Resources.
DRDPiFR	
MOS	Margin of Safety
NRETAS	Department of Natural Resources, Environment, the Arts and Sport
NWQMS	National Water Quality Management Strategy
PCC	Palmerston City Council
PWC	Power Water Corporation
STP	Sewerage Treatment Plant
TDML	Total Daily Maximum Limit
TRaCK	Tropical Rivers and Coastal Knowledge Consortium
WAP	Water Allocation Plan
WQO's	Water Quality Objectives
WQPP	Water Quality Protection Plan
WSUD	Water Sensitive Urban Design

Section 1. Introduction

1.0 Overview

The Darwin Harbour region is the country of the Larrakia and other Aboriginal people, and is enjoyed by Territorians and tourists for its recreational opportunities. Most Territory residents live in the region, which is the centre for industrial and commercial activities. The region is also a major hub for road, rail, air and sea transport. Our use of the catchment, through urban, industrial and agricultural development in the region has increased the amount of pollutants entering Darwin Harbour.

Continued growth of urban and rural activities around Darwin Harbour will place increasing pressure on the Harbour's waterways. Currently, the assimilative capacity of the Harbour to receive pollutants from point and non-point sources is poorly known and improved monitoring and knowledge is required to ensure the recreational, social, environmental and economic values of our waterways are not degraded.

At present waters in the Darwin Harbour region are considered to be in good condition compared to those adjacent to highly populated areas in other regions of Australia. This is reflected in the good reputation that the Top End enjoys for its ecological diversity, recreational opportunities such as fishing and its distinctive tropical character.

There are, however, areas of concern, especially around some urbanised areas where sewage outfalls, stormwater, or pollution in the form of pathogens and nutrients, can affect the quality of the water. It is important to recognise that the environmental quality of these waters in the future will strongly depend on the decisions we make now.

It is vital that we maintain the harbours current 'good shape' and ensure that water quality is not degraded.

This report describes the development of Water Quality Objectives, Pollutant Load Targets and priority research undertaken to inform a Water Quality Protection Plan (WQPP) for the Darwin region. The development of this plan recognises that many of the Harbours waterways are ecologically intact and are important for the economic, social and spiritual benefits they provide. Striking the balance between these sometimes disparate values and ensuring resources that the region contains are utilised sustainably is an important underpinning goal in the development of current and future strategies for the region.

1.1 Development of a Water Quality Protection Plan

An action plan is to be developed for the Darwin region through the use of the Framework for Marine and Estuarine Water Quality Protection. This plan is called the Water Quality Protection Plan for Darwin Harbour (WQPP). The aim of the WQPP project is to ensure that Water Quality Objectives, a key component of the Plan, are maintained and that community's values associated with various waterways are protected. The development of this plan has been made possible through funds provided by the Australian Government under the Coastal Catchments Initiative.

The proposed framework for the WQPP (Figure 1) will provide the basis for which to progress beyond the first preparatory phase of the plan. Key components will include Modelling, Monitoring and Implementation strategies for the region which will support the approach outlined by the framework.

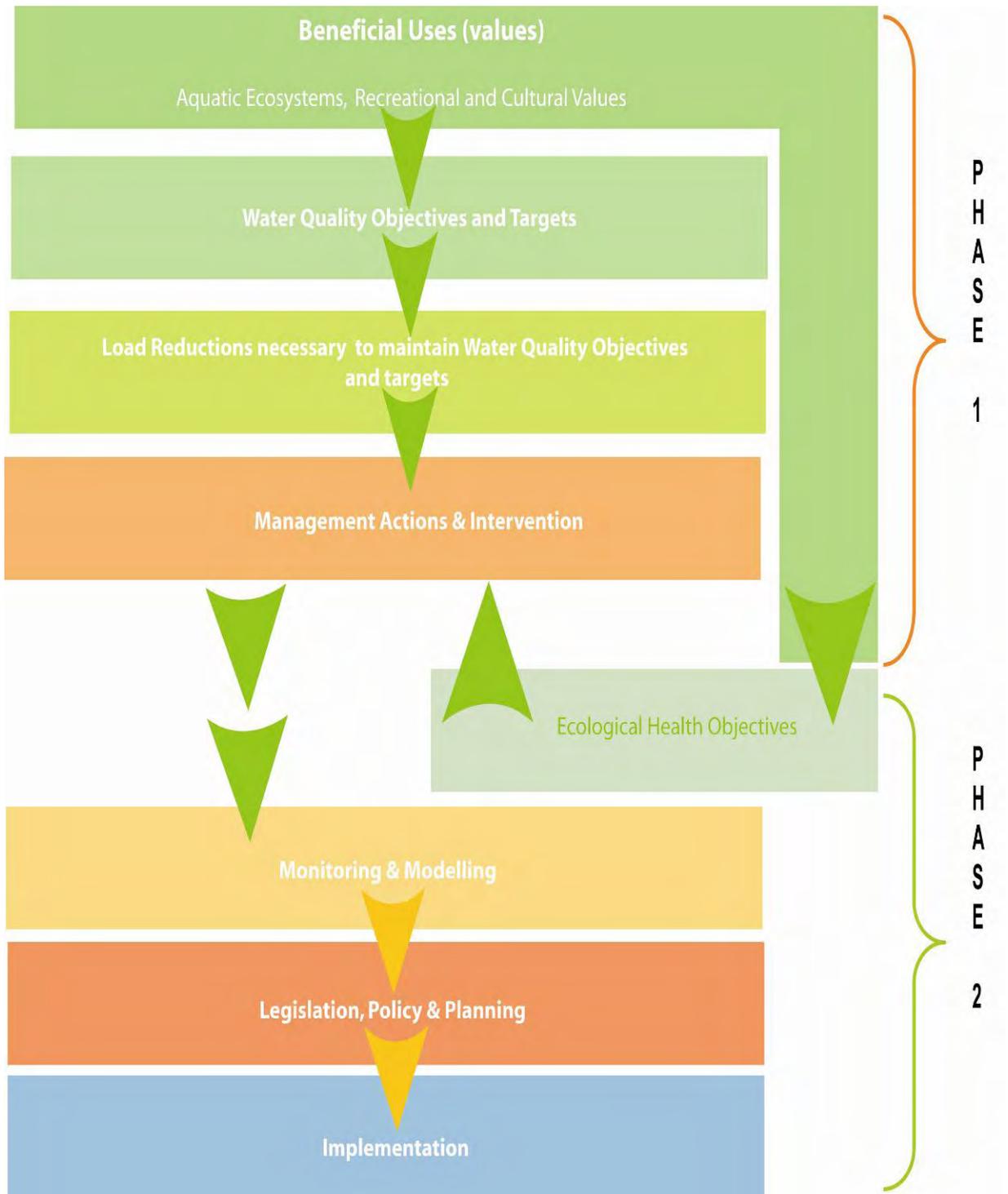


Figure 1.1 Proposed outline of the Water Quality Protection Plan for Darwin Harbour.

1.2 The Darwin Harbour Region

Compared to other Australian states and most other countries, our cities and towns are nestled amongst natural landscapes. There is no legacy of environmental decay or pollution in the region which has necessitated measures to rehabilitate aquatic ecosystems, restore rivers or wetlands. We do not have to spend considerable resources attempting to address water quality which from experience elsewhere in Australia and internationally is nearly always invariably expensive and often futile. This makes Darwin Harbour a special place which is prized by Territorians and visitors to the region.

Darwin Harbour and its catchment is defined by a line between Gunn and Charles Point, and includes Port Darwin and Shoal Bay (Figure 2). The 2010 km² terrestrial catchment, that being the land above the harbour's high water mark, comprises the cities of Darwin and Palmerston, a predominately rural hinterland and undeveloped areas. The major rivers flowing into the harbour are the Howard, Elizabeth and Blackmore Rivers.

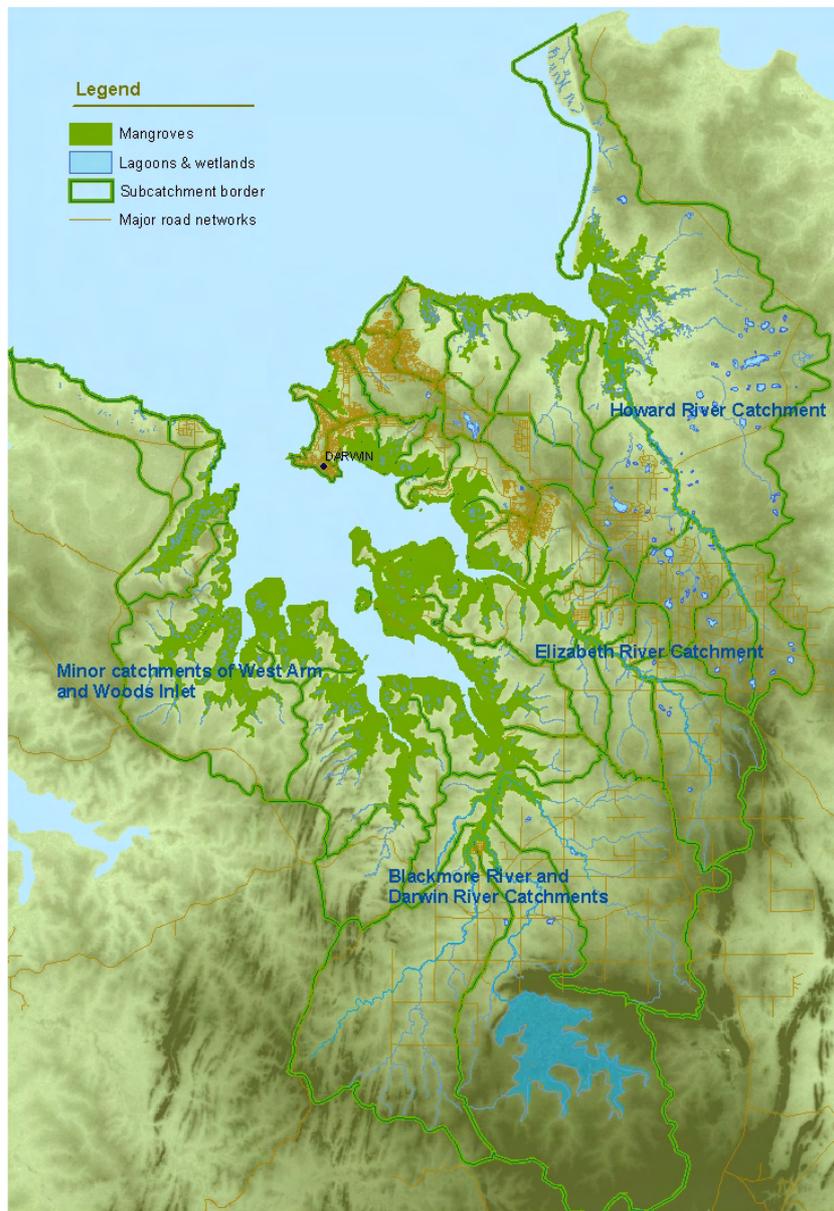


Figure 1.2: Major Subcatchments of the Darwin Harbour Region.

The area of the terrestrial catchment to the estuary ratio for Darwin Harbour is approximately 2:1, which is relatively small. This means that the areas that can generate potentially polluted run-off that flows into the harbour is less than for other proportionally large catchments, such as Brisbane's Moreton Bay or Sydney's Port Jackson (Darwin Harbour Advisory Committee, 2003). Darwin Harbour has naturally deep channels that are 10-12 m deep and extend into

the three major arms: East Arm, Middle Arm and West Arm. The harbour is fringed by mangroves, mud flats, rocky foreshores, low cliffs and sandy beaches.

Darwin Harbour is a large macro-tidal estuary that experiences tidal variations up to 8 metres. The mean spring tidal ranges approximate 6 metres, whilst mean neap tidal ranges are around 3 metres. The harbour's tides are semi-diurnal, with two high tides and two low tides daily. These macrotides produce strong currents that can peak at speeds of up to 2-2.5m/second. Tidal flows between East point and Mandorah have been measured and found to be in the order of 120,000 cubic metres per second (Williams and Wolanski, 2003).



Figure 1.3: Turbid plumes resulting from macrotidal regime in the Darwin Harbour estuary.

The catchment's geology is ancient and highly weathered, consequently most soils in the region have poor fertility. The topography of the catchment is relatively low-lying with most land being less than 30 metres above sea level. Inland plains are flooded with fresh water to a depth of up to two meters each wet season.

Darwin city lies on the north eastern side of the Harbour and supports the largest concentration of the Northern Territory population. Growing urbanisation, industry and clearing in the catchment contribute to increasing diffuse and point source loads to the harbour. Impacts appear to be confined to localised areas of the harbour, whilst much of the region remains in a healthy state with some areas such as West Arm considered relatively pristine (Water Monitoring Branch, 2005).

Industry is located primarily in the suburb of Winnellie fringing the eastern margin of Port Darwin. However, a number of satellite industrial estates service the East Arm Port region at Hudson Creek, whilst others are located in the Berrimah and Pinelands areas. More recently, approximately 88 hectares of Wickham Point was cleared to establish an LNG plant and its associated infrastructure. Industrial and manufacturing land-use, including the port, constitutes 0.15% of land-use in the catchment or approximately 990 ha. Approximately two percent of land-use in the catchment has been developed for horticulture. These areas are located primarily in the Litchfield and Coomalie Shires.

1.3 Larrakia Country

The harbour has been home to the Larrakia people for thousands of years. For the Larrakia the region's environments are 'cultural landscapes' that are vital to their well-being. A rich oral history links land, sea and culture from generation to generation.

Larrakia still have ceremonies, walk their country, camp, hunt, fish and gather plant foods and materials as part of maintaining culture. Numerous Larrakia sacred and archaeological sites occur in the region's land and seascapes with many sites recorded and sacred sites registered within the region. Some of these are 'Dreaming sites' associated with animals, plants or people.

Favourite Larrakia sea foods include dugong *Damaldangala*, turtle *Dawudlirra*, sharks and rays, bream, barramundi, salmon, trevally, mackerel, mullet, mud crab, long-bum *Danijarra*, mud mussel *Damagula* and periwinkles (Darwin Harbour Advisory Committee, 2003). Coastal bush fruits include the Bush Peanut and Pandanus. Rotten Cheesefruit is used for coughs and colds and smoking pipes are made from beach hibiscus, *Larrwa*, timber and crab claw.

Burial sites are located around the coast, including Mindil Beach. Other archaeological sites include shell middens, camping sites and stone fish traps. Stone artefacts are also found around the coast. Popular campsites, past and present, often have freshwater and abundant food sources nearby.

Maintaining this natural asset for its highly regarded ecological, recreational and cultural values remains paramount. There is an ongoing need to monitor and model increasing pressures from the catchment to maintain water quality for Beneficial Uses of the region and aid decision making for the sustainable management of Darwin Harbour. The monitoring and modelling applications pursued as part of the Water Quality Protection Plan (WQPP) will enable us to not only inform decision making processes for sustainable development but to importantly understand the underpinning processes which characterise this estuary.

1.4 Water Quality Issues in the Region

Land use change including land clearing for irrigation, horticulture, agriculture and urban development can result in a range of impacts and pressures on waterways. Altering hydrology, increasing rates of erosion, water extraction, nutrients and chemical pollutants entering waterways, to weed and feral incursions which alter fire regimes are some of the impacts associated with increasing development pressures.

Urbanisation probably has one of the most dramatic effects of any land-use on catchment runoff. Urban and commercial developments have large areas of hard impervious surfaces such as roads and roofs that limit infiltration to the ground. This results in a greater volume of runoff. Existing developments have used efficient stormwater drainage designs to convey the runoff from these areas as quickly as possible to minimise the risk of flooding and inundation. This reduces the time it takes for water to leave the catchment and enter rivers and creeks and can lead to higher flow but shorter duration peaks in the stream flows. The increased flow velocities associated with this runoff can result in higher rates of erosion if urban drains and streams are not adequately stabilised. Contemporary urban drainage design seeks to return the runoff regime to a more natural setting.

On a whole of harbour scale, the contributions from diffuse runoff and point source sewage discharges to the overall nutrient status of the harbour are relatively minor. However, current research suggests that the effects of point and diffuse sources of nutrients may be significant at more local scales such as in the tidal creeks or the upper reaches of the estuary where point source nutrient are discharged. The hydrodynamic model developed for Darwin Harbour suggests that the upper reaches of the estuary experience extended residence times (Williams and Wolanski, 2003; WRL 2008). This understanding, coupled with the forecasted nutrient load contributions make these areas of extended residence time particularly vulnerable to localised nutrient impact.

Sources of nutrients include point-source discharges (particularly sewage discharges) and runoff from urban and rural areas. These pollutant sources present the greatest management issue for water quality in the region (Fig 4). Catchment areas that have been cleared of vegetation typically provide more nutrients than areas in their natural state. Potential consequences of increased nutrient loads to estuaries include eutrophication, algal blooms or excessive macrophyte growth, anoxic events due to decay of plant matter, and fish or animal kills from lack of oxygen.

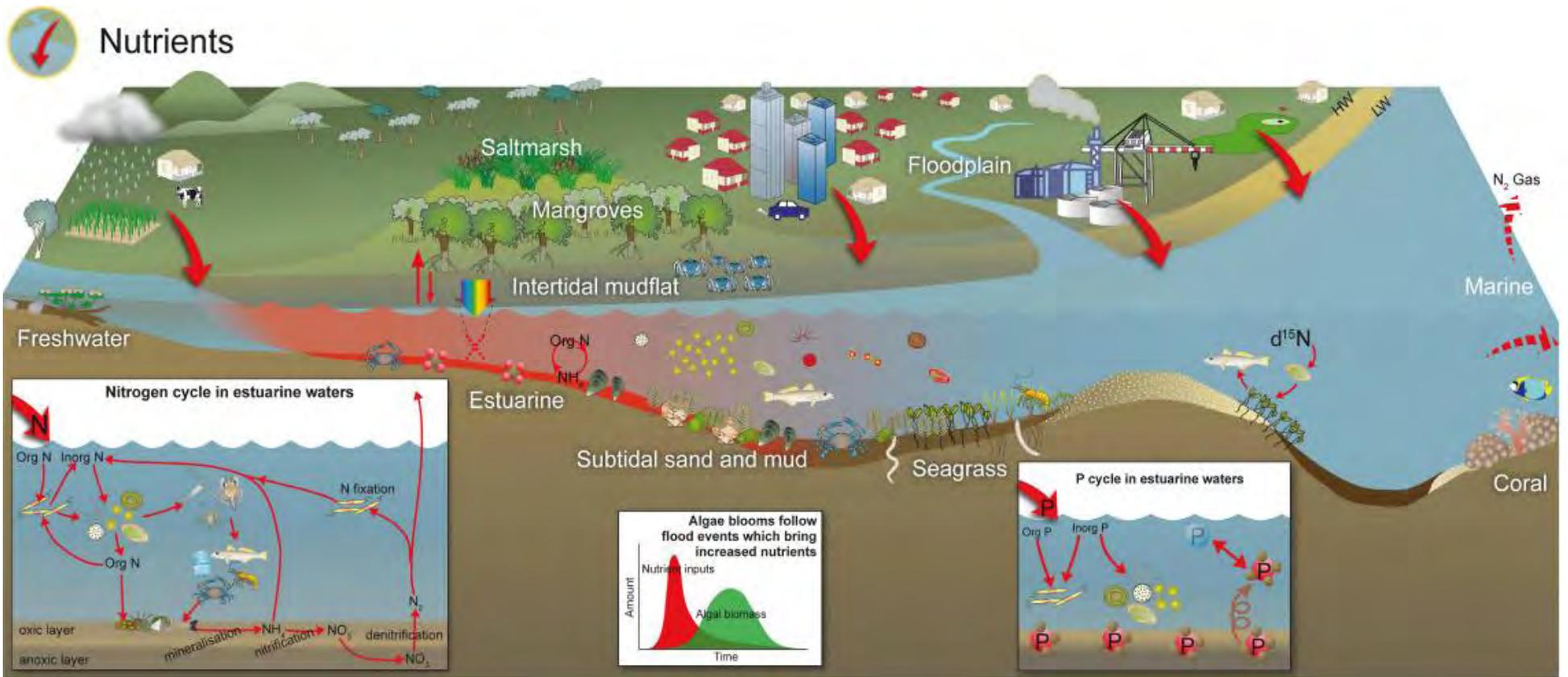


Figure 1.4: Conceptual diagram of nutrient pollutants entering a waterway and effects on receiving environments (Source Qld EPA).

Estuarine monitoring has continued since the early 1990's however there is a need to intensify effort and build on a program which incorporates other attributes such as biota and habitat indicators. Monitoring of freshwater rivers and streams at a series of sites across the broader Darwin region catchment has included water quality and biological assessments with particular focus on macroinvertebrates. Future research efforts will trial additional indicators of aquatic health including fish, amphibians, riparian health and river metabolism.

Achieving protection of aquatic ecosystems requires management of not only water quality but also other attributes of the system such as flow for environmental requirements and habitat condition as indicated above. Any assessment of ecosystem health needs to indicate the measurement of biological indicators as well as the indirect assessment of system modifiers such as water quality. Measurement of these modifiers is important in determining causes of detected changes to biological attributes. In the case of ecosystem protection there is a plethora of possible indicators to choose from. Monitoring all potential indicators is impractical and a process to select the most appropriate indicators was undertaken in conjunction with the preparation for a WQPP.

1.5 Beneficial Uses

Environmental values are particular values or uses of water that are conducive to a healthy ecosystem and/or contribute to public benefit, welfare, safety and health. These environmental values require protection from the effects (both on-going and potential) of pollution, waste discharges, and waste deposits. The Northern Territory *Water Act* defines these values or uses as Beneficial Uses and a given water body may have none, one, a number, or all of the following Beneficial Uses:

	Agriculture – to provide irrigation water for primary production including related research;
	Aquaculture – to provide water for commercial production of aquatic animals;
	Public water supply – to provide water for drinking purposes;
	Environment – to provide water to maintain the health of aquatic ecosystems;
   	Cultural – to provide water to meet aesthetic, recreational and cultural needs;
	Industry – to provide water for industry; and
	Rural stock and domestic – to provide water for specific use

A number of high conservational value ecosystems have been identified in the region. Many of these are protected zones and include important marine, estuarine and freshwater habitats and species. These include areas such as the Casuarina Coastal Reserve, Doctors Gully Aquatic Life Reserve and Berry Springs Nature Reserve. Areas of high conservational significance attract a higher level of protection and therefore no change to natural values would be determined for such zones.

Beneficial uses have now been established through community consultation for the subsequent determination of water quality objectives (WQO's) and targets. The underlying principle of the development of these Objectives and Pollutant Load Targets is the protection of beneficial uses, with particular emphasis on the preservation of aquatic ecosystems (environmental use), recreational and cultural values.

1.5.1 Consultation Process and Darwin Harbour Advisory Committee

Beneficial Uses for regional waters were first declared in 1996 as part of the National Water Quality Management Strategy, a long term plan of action developed by the Federal, State and Territory Governments in 1992 to ensure a sustainable and nationally consistent approach to water quality management. Since that time a significant portion of the catchment has been developed. It was therefore appropriate to review the nominated uses. To ensure that current Beneficial Use declarations still reflect values and uses of water by the community, a consultation process was undertaken which sought to determine how and for what purpose should water in the catchment be used. A detailed list of consultation objectives can be found in the project's consultation strategy.

The consultation process was facilitated by the Darwin Harbour Advisory Committee (DHAC) a key partner in the development of WQPP, whose members represent groups and organisations with an interest or responsibility for the management of all aspects of Darwin Harbour and its catchment. The Committee was established in 2002 to develop, review and oversee the implementation the Darwin Harbour Regional Plan of Management. Much of the Committee's and its technical reference groups early work and recommendations also inform the preparation of WQPP. The Committee's role in the WQPP project is to facilitate community consultation and engagement processes as outlined in the consultation strategy.

The public consultation process took place from April to June 2007. Over 400 information packs containing flyers, fact sheets, contact details for further information and feedback forms were distributed via mail, e-mail, at fairs, shows and at information sessions. DHAC database containing 200 individuals and organisations who expressed an interest in management of the Harbour was also utilised in relation to the consultation process in addition to a comprehensive media campaign which included media releases, interviews with DHAC Chair and project team members during prime time afternoon time slot and a number of newspaper articles.

Three public forums were held across the catchment (at Cox Peninsula, Darwin's rural area and in Darwin CBD) where experts presented information about Beneficial Uses and discussed the role of environmental values in the water quality management process with the participants. All of the information was also made available electronically on the WQPP website including an electronic feedback form.

1.5.2 Outcomes from the Consultation Process

A total of 64 submissions were received at the conclusion of the consultation period. A table showing distribution of preferences for various uses of water in 9 different areas is in Appendix A. Table 1 summarises the nominated beneficial uses for major catchments and systems in the Darwin region.

A key outcome from the consultation process was the community's preference for existing uses to be retained and for environment to be the highest ranking category of beneficial use for all waterways in the catchment.

The Darwin Harbour region is the country of the Larrakia and other Aboriginal people. Larrakia 'country' consists of both land and sea, and there is strong unbroken relationship to their land, sacred sites, stories and resources through oral and written history. Consultation with the Larrakia Harbour Committee (LHC) identified a number of values falling under one overarching principle – that all water is valued and that the traditional and cultural use of the Harbour is innately tied to an intact environment. The ongoing advice and development of water quality and ecological objectives which are culturally appropriate is continuing with the assistance of the LHC.

WATER REGIONS		1	2	3	4	5	6	7	8
		Darwin Harbour & its marine reaches	Rapid Creek freshwater reaches	Elizabeth & Howard Rivers Region – surface water	Elizabeth & Howard Rivers Region - groundwater	Darwin & Blackmore Rivers Catchment-surface water	Darwin & Blackmore Rivers Catchment-groundwater	Shoal Bay & Vernon Islands	Hudson Creek & tributaries
WATER USE CATEGORIES									
AGRICULTURAL	Use of the water body for irrigation and livestock				✓		✓		
CULTURAL	Collecting food (e.g. fish, crabs, shellfish)	✓	✓	✓		✓			
	Spiritual values	✓	✓	✓		✓			
	Recreation (e.g. swimming, fishing)	✓	✓	✓		✓			
	Aesthetics (visual)	✓	✓	✓		✓			
AQUACULTURE	Aquatic food farming								
PUBLIC WATER SUPPLY	Drinking				✓		✓		
	Other domestic uses				✓		✓		
ENVIRONMENT	Habitat for plants and animals	✓	✓	✓	✓	✓	✓	✓	✓
RIPARIAN	Access to water body by people and livestock			✓		✓			
MANUFACTURING INDUSTRY	Water for industry								

Table 1.1. Nominated beneficial uses for major catchments and systems in the Darwin region.

1.6 Water Quality and Environmental Flows Management in the Darwin Region

Northern Territory's water resources are managed through a regulatory framework prescribed by the *Water Act* and *Water Regulations*. The key principle on which this legislation is based is that the management of water is guided by its value which is in turn determined by its use or its purpose. The Beneficial Uses and water bodies to which they apply are formally declared by the Administrator in the Gazette. The primary decision maker under the *Water Act* responsible for all other aspects of water management is the Water Controller.

Department of Health and Families has responsibility for the management of water quality if it becomes an issue of public health. Consequently the Chief Health Officer of the Department of Health and Families has the responsibility for maintaining and updating Water Quality Objectives for cultural or recreational uses. These are typically based on national standards and are implemented by Power and Water Corporation.

Other legislation and decision makers relevant to the management of water quality include:

- Advisory committees such as the Darwin Harbour Advisory Committee (DHAC) and the Rapid Creek Advisory Committee (RCAC) which have some influence over water quality in Darwin Harbour through the recommendations they provide to the Minister for Environment and Heritage on issues relating to the management of land and water in Darwin Harbour catchment.
- City and Shire Councils make decisions and undertake functions listed in Schedule 2 of the *Local Government Act* which includes provisions for the management and disposal of stormwater but does not specify any responsibility for its quality. Department of Planning and Infrastructure has similar responsibility under the *Control of Roads Act* for the management of stormwater in road corridors owned by NT or Australian Government
- Darwin Port Corporation operates under the provision of the *Darwin Port Corporations Act* which amongst other functions vests the control and regulation of the use of all waters of the Harbour's port and other marine activities to the Corporation. In this capacity Darwin Port Corporation is another important decision maker with a relative influence on water quality in the Darwin Harbour.

1.7 The Role of Natural Resource Management Board NT Inc. in preparation of a WQPP

The NRM Board (NT) Inc. has been established in order to implement a strategic approach to natural resource management through the Northern Territory Integrated Natural Resource Management (INRM) Plan and Regional Investment Strategy (RIS), as agreed from time to time by the Northern Territory and Commonwealth Governments. The NRMB (NT) is responsible and accountable for:

- identifying and integrating opportunities and priorities for the management of the natural resources of the Northern Territory particularly through review of the INRM Plan and RIS as appropriate;
- promoting and nurturing partnerships aimed at achieving the outcomes of the INRM Plan;
- managing investment funds made available to it by governments or other investors; and
- reporting to stakeholders (including managers of natural resources, community organisations and groups) on the processes for and outcomes of such investments.

A partnership in a form of an MoU was developed with the Board which will assist the integration of relevant elements of the WQPP into the regional NRM and Investment initiatives.

The Memorandum of Understanding commits the parties to:

- the delivery of Management Action Targets identified in the NRMBs Integrated Natural Resource Management Plan for the Northern Territory; and
- share information as it comes available because communication and co-operation between the Department, responsible for delivering project outcomes and the NRMB is essential to maximise the use of knowledge and resources and to assist the Board in revision of its INRM Plan.

1.8 The Project Steering Committee

The WQPP project is overseen by a steering committee chaired by the Executive Director Environment and Heritage from the Department of Natural Resources, Environment, the Arts and Sport (NRETAS), which has the principal contractual obligations to undertake the project. Other members of the committee are sourced from the Department of Planning and Infrastructure, Darwin Harbour Advisory Committee and the Australian Government Department of the Environment, Water, Heritage and the Arts. The Steering Committee considers and endorses reports, timeframes, communications and consultation strategies.